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Male, two-thirds natural size
From a painting by Don R. Eckelberry

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OBSERVATIONS ON SALT BALANCE AND BEHAVIOR OF LAYSAN AND BLACK-FOOTED ALBATROSSES IN CAPTIVITY

By HUBERT FRINGS and MABLE FRINGS

In January, 1958, we had the opportunity to observe on Midway Island in the Pacific Ocean the behavior of the two species of albatrosses that breed there: the Laysan Albatross (*Diomedea immutabilis*) and the Black-footed Albatross (*D. nigripes*). While engaged in this, we checked briefly for evidence of activity of the nasal gland in these birds. Schmidt-Nielsen and co-workers (1957, 1958) reported that the nasal gland in cormorants, gulls, pelicans and penguins excreted a concentrated salt solution which dripped from the tip of the beak after administration of salt loads. Since the nasal gland is well developed in albatrosses (Bennett, 1834; Technau, 1936), it seemed reasonable to believe that this gland might function similarly in them.

The birds were, therefore, observed with this in mind, and it was noted that after fighting among the Black-foots, or occasionally during the ritual dancing, some of the birds showed drops of fluid at the tips of the beaks. Furthermore, during a local harassment campaign, many of the birds in the treated area were actively dripping. This suggested that the gland could be activated by "stress" or excitement.

On returning to Pennsylvania State University, we decided to obtain some of the birds for a study of the nasal gland, and through the kindness of the United States Navy we received eight live albatrosses, four of each species. This paper describes the methods devised for keeping the birds in captivity and presents some observations on their behavior.

MAINTENANCE OF BIRDS IN CAPTIVITY

Marine birds have proved to be notably difficult to keep alive and healthy in captivity (Pallesen, 1940; Hadden, 1941; Plath, 1943). Laysan and Black-footed albatrosses had not previously been kept in captivity for more than a few months, and most of these died within a few weeks. An examination of privately shared records of feeding and handling of these birds (Malcolm Davis) indicated to us that most of these efforts had failed because of three factors: (1) the birds were usually force-fed; (2) they were given invertebrates, such as squid (*Loligo* sp.), for food; and (3) they were given fresh water instead of sea water to drink.

The rationale behind this is the following. The studies of Schmidt-Nielsen and his colleagues indicate clearly that the nasal gland of marine birds removes excess NaCl and some KCl from the blood. The gland does not, however, remove divalent cations, such as magnesium and calcium ions. As a matter of fact, NaCl is preferentially excreted by the nasal gland no matter what sort of osmotic load is imposed. Theoretically, at least, this should make possible the drinking of sea water by the birds. We had noted that excitement or "stress" caused the nasal gland to become active when ordinarily it would not be. Thus, "stress," such as force-feeding, could force the sodium level of the blood down. The typical pathology seen in the captive albatrosses before death was a progressive lassitude and seeming anaesthesia, with no observable lesions. This suggested that the birds were suffering from a decrease in the ratio of sodium ion to divalent cations in the blood. If this were true, the feeding of invertebrates, such as squid, which

have a much higher level of magnesium and calcium with respect to sodium than have vertebrates, would intensify the problem for the birds (see tables 9 and 11 in Prosser, 1950; tables 38 and 53 in Spector, 1956). Furthermore, if only fresh water were available for drinking, the birds would have no means for restoring the sodium concentration by drinking sea water.

On the basis of this reasoning, we decided that: (1) the birds would not be force-fed, thus reducing the "stress," (2) they would be given only vertebrate food, namely fish, which has the ratio of sodium ion to divalent cations much more like that of the blood of birds, and (3) they would be given sea water to drink. It is worth noting that there are a few reports in the literature on the salutary effects of sea water on marine birds in captivity (for example, Townsend, 1927), but these were not based on physiological knowledge.

The eight birds arrived on April 18, 1958, and were housed in an abandoned henhouse (20×10 ft.) on one of the university farms. This had wooden walls and a concrete floor covered with dry sawdust. There were five small windows; one at each end and three near the roof along one side. There were no facilities for heating, but the weather was pleasant at first.

We had no natural sea water available and were not yet equipped to produce large quantities of artificial sea water. Accordingly, a large wading tank holding about 30 gallons, which was furnished for possible swimming or bathing, was filled with ordinary well water. Artificial sea water was supplied in a bucket, in the belief that the birds would be able to select this for drinking, if needed.

Frozen blocks of trash ocean fish were obtained through the kindness of officials of The Pennsylvania State Fish Hatchery at Pleasant Gap, Pennsylvania. After thawing sufficiently to allow the fish to be separated but still individually frozen, the fish were cut into pieces about 4 to 6 inches long and 1 inch on a side. These were offered by hand to the birds. The Black-footed Albatrosses quickly learned to feed this way. One was feeding regularly within the first two days, the second in three days, the third within five days, and the last within a week. The Laysan Albatrosses, in general, proved difficult to induce to feed. As was later discovered, this was the result of our ignorance of differences in feeding behavior between the two species. If proper techniques had been used, the Laysan Albatrosses would certainly have been no more difficult to train than the Black-foots. The feeding behavior will be described in detail later.

At this time, we had no idea how much salt was required by the birds. On the basis of published reports on the nasal gland, it seemed possible that they could meet this requirement from the fish itself, provided they were not force-fed. This seemed to be supported by the fact that the Black-foots remained in reasonable health, while the Laysans, which were not feeding, gradually declined. Within six days (April 26) one of the Laysan Albatrosses was dead, after showing a gradual depression, dropping from an upright stance to squatting on the ankles (with the tarsometatarsal portion of the leg flat on the ground), and becoming generally inactive. Unfortunately, however, the interpretation of this series of events was confused by the fact that the weather suddenly became unseasonably cold, and there was some question as to the possible contribution of this to the death.

Two other Laysans were declining rapidly. It was now noted that they were drinking mainly the fresh water in the wading pool instead of the sea water in the bucket. Later observations make it reasonable to believe that this occurred simply because there was much more surface available in the wading pool. These unhealthy birds became rapidly worse and, within a day, dropped to the ankles as the other had done. In the belief that the cold weather could be an important factor—for even the Black-foots were now

beginning to keep their feet pulled up into the feathers unless driven to stand—arrangements were made to move the birds to new quarters which could be heated.

Before this could be done, however, the second Laysan Albatross died. On April 28, one of the Black-footed Albatrosses was killed for anatomical study, and the Laysan, which had died over the previous night, was used likewise. The third Laysan was obviously within hours of death, and the fourth, which had just started to take a little food, was noticeably depressed. Accordingly, it was decided to inject into these birds large doses of NaCl to see whether dripping from the beak, which had not been observed up to this time in any of the albatrosses, could be induced and whether this would help the situation.

The Laysan Albatross which had fed a little received 10 ml. of 0.5 M NaCl solution intraperitoneally, and the other Laysan received 25 ml. of the same. Neither showed dripping from the beak after this, but the recovery in both was startling. Within 10 minutes after the injections, the birds were upright and walking about quite normally. Obviously, these birds had been heavily deficient in sodium. They had also been observed repeatedly drinking fresh water. Apparently, sodium deficiency caused the birds to drink, but discrimination between fresh and salt water was lacking. In nature, of course, mere drinking would bring about increased salt intake, because only sea water would be available.

The birds were now moved to new quarters, a circular sheet metal turkey pen (about 15 feet in diameter and 10 feet high) with five windows comprising about half the wall area. Two small electric glow-type heaters were suspended from the ceiling and could be turned on and off as needed. This allowed considerable manipulation of the temperature, except on sunny days, when the temperature inside mounted sharply. There was no provision for the birds to be outside. A layer of coarse, dry sawdust, about 6 to 8 inches deep, was put on the floor to absorb the liquid feces.

On the basis of the results with NaCl injections, all the birds were given gelatin capsules containing 0.8 gm. of NaCl imbedded in fish. The Laysans were force-fed to get the medication into them; the Black-foots ate regularly. Two NaCl capsules were required for each bird to induce dripping of fluid from the beak. The improvement in general health and activity in all the birds was striking.

This led to a study of the action of the nasal gland, using these five birds; the results have been published elsewhere (Frings, Anthony, and Schein, 1958). The nasal glands of these birds excrete NaCl and KCl in a solution containing 792–856 mEquiv/lit. Na^+ and 20–28 mEquiv/lit. K^+. The concentrations of these ions in the blood of non-excreting but sodium-sufficient birds is the same as that of actively excreting birds. The blood sodium and potassium levels are held by the glands to an absolute maximum.

The paired nasal glands discharge this salty liquid through small openings beneath the tube-nostril, whence the fluid flows along the grooves on the beak to drip off the end. When actively excreting, after a heavy salt load, these drops may fall at 2 to 4 second intervals, but more usually they fall at about 5 to 10 second intervals. The birds either allow the drops to drip off or shake them off. The tube-nostril would seem to be an adaptation of these marine birds which prevents fouling of the nostrils by the liquid excretion of the nasal glands.

It was now obvious that the activity of the nasal glands, which could be so easily observed by watching for dripping of liquid from the tip of the beak, could be used to test for sodium sufficiency. After this time, the birds were given salt either in gelatin capsules or in commercial salt tablets, such as are used for humans, by imbedding these in the fish on which they fed. The wading pool was filled with artificial sea water made by dissolving the necessary amount of rock salt in fresh water. No fresh water was avail-

able, except for a few times when large loads of salt were administered experimentally and this precaution seemed advisable. Even then, however, the birds were not observed drinking it. They were seen drinking the artificial sea water many times. Within a few days, the Laysan Albatrosses joined the Black-foots in feeding regularly from the hand, and no further difficulties were encountered in keeping these birds in excellent health and activity. In June, all were shipped by air to the laboratory at Salisbury Cove, Maine, where they were kept in an enclosed house (9 × 6 feet) and attached outdoor runway (9 × 16 feet). The floor of the house was covered with coarse sawdust; the runway was part of a lawn. The feeding regimen was continued as before, and true sea water, which all were seen to drink many times, was given in a small tub holding about four gallons.

The birds were fed once daily with pieces of fish. These were frozen for ease in cutting and kept frozen until feeding time. They were then thawed, but cool. The birds were given one salt tablet each imbedded in a piece of fish every two or three days and, if not observed dripping after feeding for four or five days, were given an extra tablet and observed. Once the sodium balance was established, dripping from the beak occurred almost every day that salt tablets were fed. Once a week, multi-vitamin capsules were also fed in the fish. There were no evidences of vitamin deficiencies, but this seemed a reasonable precaution.

A number of species of fish were used for food, all about equally acceptable to the birds. At Pennsylvania State University, whiting (*Merluccius bilinearis*) was most usually used, in Maine, haddock (*Melanogrammus aeglefinus*) and hake (*Urophycis* sp.). Pollock (*Pollachius virens*), flounder (*Paralichthys oblongus*), ocean pout (*Macrozoarces americanus*), halibut (*Hippoglossus hippoglossus*), tuna (*Thunnus thynnus*), and herring (*Clupea harengus*) were also given.

The amounts of fish eaten varied widely from day to day, from as much as 5 to 6 pounds to 2 to 4 ounces for the five birds. Consumption of fish was reduced noticeably if the fish was warm instead of cold, if salt was sprinkled on it, or if an oily material, such as cod liver oil which was tried as a vitamin supplement, was poured on it. If the fish were allowed to thaw, then were refrozen and later rethawed and offered to the birds, intake dropped markedly. New foods were usually accepted very eagerly when first offered, but if continued daily, they were soon accepted like the usual items.

On the basis of reports of the eating of garbage, especially fatty materials, by Black-footed Albatrosses (Bent, 1922; Miller, 1936, 1940, 1942; Fisher, 1945; Yocom, 1947; Thompson, 1951), raw beef scraps and fat were offered, and these proved to be eminently acceptable. In fact, when the birds had stopped feeding on fish, apparently satisfied, they would take beef fat avidly. Veal, pork or turkey scraps and fat also were taken eagerly, even bread dipped in bacon fat or vegetables covered with fat or oleo. Ordinarily, after the birds reached Maine, they were given fish to eat first and then some raw beef fat. Under these conditions, the most usual daily consumption of food was about 2½ pounds of fish and 6 to 10 ounces of beef fat for the five albatrosses.

The birds were weighed three times during the four months we had them, and they remained essentially the same in weight. Two of the Black-footed Albatrosses, which we took from their behavior to be males, weighed 6 pounds each, the other, which we took to be a female, weighed 5½ pounds. The two Laysans weighed 5 pounds each. The sexes are indistinguishable externally, but the weights for the Black-foots gave support to the tentative diagnosis of sex based on aggressive behavior and appearance. Loomis (1918) reported that females average less in size than males in these species.

At first, there was some question about the possibility of overfeeding salt to the birds. This seemed, however, to be next to impossible. To enable us to collect specimens of the nasal drip, the birds were given up to 2.4 grams of pure NaCl in capsules in pieces of

fish. The birds already had normal sodium concentrations, and they were thus induced to drip rapidly for some hours but without obvious effects. Shortly after the birds reached Maine, they were given herrings which were heavily salted preparatory to being canned as sardines. They dripped from shortly after feeding, at about 5 p.m., until about midday the following day, but they seemed quite normal and fed regularly.

The dripping from the beak began in a remarkably short time after the birds had eaten pieces of fish in which salt capsules or tablets were imbedded, almost always within 10 to 15 minutes, and often in as little as 5 to 8 minutes. This may be a reflection of a surprising rapidity of digestion or it may mean that the salt capsules or tablets were squeezed out of the food in the crop. If the former is true, and it seems more likely to us, it may account for the fact that examinations of stomach contents of albatrosses have often revealed few identifiable fish remains (Matthews, 1929; Murphy, 1936), although Cottam and Knappen (1939) reported, for the Black-footed Albatross, appreciable proportions of fish in the stomach. Apparently, digestion of such objects as squid beaks and eye lenses is much slower. The reports of Nutting (1903), Fisher (1906), Dill (1916), and Chisholm (1937) that these are found near the nests of Laysan Albatrosses has led to the belief that squid is the major food of this species. For this reason squid was fed almost exclusively to captive individuals by other workers. On the basis of our results, it seems quite likely that the Laysan Albatrosses, like the Black-foots, might eat whatever they can find.

To see whether they would eat invertebrate food at all, if not force-fed, whole squid (*Loligo pealeii*) and pieces of the flesh of lobster (*Homarus americanus*) were offered. The former was taken eagerly, after some hesitation at first, the latter not at all. In nature, any ionic differential produced by eating quantities of squid could easily be rectified by drinking sea water.

It would thus seem that, as originally postulated, the activity of the nasal gland in these birds—and possibly other marine birds as well—is an important factor in maintaining them in captivity. There was plenty of evidence, in these birds, that excitement or "stress" caused dripping from the nasal gland. On arrival from Midway Island, the birds were found to have the beaks covered with crystals of what was almost certainly salt. When they were handled for experiments, dripping occurred afterward. Actually, one or two birds often dripped from the beak apparently just from excitement during feeding. Force-feeding, or even attempts to coerce the birds into feeding if they showed no interest or seemed to be satisfied, was avoided. Obviously fish was fully acceptable to these albatrosses as food, and the ionic problems created by this, when some stress was unavoidable in confinement, were undoubtedly less than those created by invertebrate foods. The birds drank sea water if this was available. In sodium deficiency, intake of water increased, but without apparent selection. Thus, if fresh water was present and there was no supplementary feeding of salt, the birds could deplete their blood sodium. Apparently, the nasal gland had to be fairly active for normal health, so supplemental feeding with NaCl tablets or capsules containing NaCl or dry sea salt was essential. Activity of the nasal gland, easily visible in the dripping from the beak, made a good test for sodium sufficiency. When this was maintained, and suitable quarters and attention were given, the birds seemed to remain healthy and active in captivity, at least for the four months we had them.

On August 20, 1958, the five albatrosses were shipped by air from Maine to the National Zoological Park in Washington, D.C., where Drs. Theodore Reed and Malcolm Davis are continuing with the methods described here.

NOTES ON BEHAVIOR

A few notes on the behavior of these birds in captivity might be of interest. Their docility and fearlessness, as in nature, were striking. They could be approached to within touching distance, with only beak-snapping to ward one off. With a little care, they could be gently handled. One surprise was the ease with which the Black-footed Albatrosses became tame. On Midway Island, they are considerably less docile than the Laysans (Hadden, 1941; Bailey, 1952, 1956). Reports of regurgitation by other species of albatrosses (Matthews, 1929, 1951; Murphy, 1936), and by young Laysan Albatrosses under some circumstances (Fisher, 1904), led us to expect this during handling, but it did not occur. There was no "fishy" odor at any time near their quarters; the liquid feces, which rapidly soaked into the dry sawdust or sandy soil, had only the odor of the birds themselves, which was not at all unpleasant.

The danger from the beak, at least in these captive birds, was little. Gloves were used in feeding at first, but these were later discarded. A number of times the birds were allowed to take our bare fingers into the beak, with no effects or only minor marks. The hook at the tip of the beak could certainly tear the flesh, if one pulled away when the birds seized his hand. If, however, one did not move, they seemed to be unable to press hard enough to do much damage. If one pressed his hand toward them, they usually released immediately.

The Black-footed Albatrosses learned readily to feed from the hand and came to the person offering food when he entered their pen. They had the habit of snapping at objects dangled in front of them, and, when they had seized something, they could be induced to pull on it and move it backward in the beak by pulling in the opposite direction. Once they had thus gained a good hold on a piece of fish, they were able to force the food into the mouth by opening the beak slightly and thrusting it forward, or they could toss the fish into the air and catch it in the mouth. The Laysan Albatrosses, on the other hand, were shy, and, if they seized an object at all, seemed unable to work it back from the tip of the beak. If one pulled on an object in their beaks, they released. Thus, in the early days of their captivity, they could not be induced to feed by the methods used with the Black-foots. If, however, a piece of food or one's finger were rubbed alongside the beak about a third of the way out from the mouth, they opened the beak and the food, or finger followed by food, could be slid in. With a slight thrust, the food could then be moved into the mouth. Once in the mouth, it was almost invariably swallowed. After this was discovered, feeding the Laysans became as easy as feeding the Black-foots. Actually, one could approximate force-feeding, once the birds were trained, by merely continuing to press food on them. If the birds were hungry enough or eager enough, as for beef fat or living fish, they would pick up the food from the floor or from a dish.

Many persons feel that the name "gooney birds" for these albatrosses accurately reflects a lack of intelligence on their part. This belief in their stupidity seems to be based on observations of their awkward gait, mischances in landing from flight, and extreme docility. Actually, none of these has any real relationship to intelligence or adaptability. We are convinced, after observing these birds closely, that they are among the more intelligent and adaptable of birds. Pallesen (1940), describing the behavior of a captive Galapagos Albatross (*Diomedea irrorata*), also noted the ease with which the bird could be trained.

These albatrosses adjusted remarkably well to captivity, in spite of the vast changes in habits and climatic conditions involved. They rapidly learned to associate the gloves with food. Two of the Black-footed Albatrosses came immediately to a person with the gloves within two days after they arrived from Midway Island. A pair of gauntlets,

similar in appearance to the gloves, was used in handling the birds for experiments. After only one series of captures, they distinguished between the gloves and gauntlets, clustering around anyone who wore the gloves and avoiding anyone who put on the gauntlets. Within two weeks, they gathered near the doorway for feeding only at mid-afternoon, the daily feeding time. Furthermore, if we arrived in our automobile, in which we usually drove to their pen, they hurried to the windows and started scrapping for position. If, on the other hand, we came in some other automobile, they paid no attention until we had stepped from it with their feeding dish. Many other examples could be cited.

The three Black-footed Albatrosses, as is their wont in nature (Hadden, 1941; Bailey, 1952, 1956), were more aggressive among themselves than the Laysans and set up a dominance order based on some fighting. After the first few bouts, this never achieved more than ritualized fighting, and at no time did they injure each other. The aggressive behavior took place almost entirely before feeding, when they could see someone coming with food. The two Laysan Albatrosses did not show any aggressive behavior, and, in general, were more shy than the Black-foots, but they did resist aggression by the Black-foots by beak-snapping and fencing.

At Pennsylvania State University, the birds were given a large wading tank in the belief that they would swim or bathe in this. There was no evidence, however, that this happened. One of the Black-footed Albatrosses was wet occasionally in the mornings, but whether voluntarily or accidentally was not determined. They became progressively less tidy and were finally forced into the water a few times and bathed.

When they arrived in Maine, however, we could not find a wading tank, and sea water was provided in a small tub for drinking only. Before this situation could be changed, a rain storm came, and it immediately became obvious that these birds could bathe in rain. All spread their wings and flapped in the falling droplets, snapping at them all the while. They ran their beaks through their feathers, using a scissors-like action, and generally cleaned and preened. Interestingly enough, they even used the wet grass to scrub their heads by rolling them in it from side to side rapidly and vigorously.

This discovery led us to give them a lawn sprinkler for bathing. This was turned on for about an hour every three or four days, or once a day when the temperature was high. The reaction was the same every time—active bathing, flapping the wings and jumping up and down, some screaming, and snapping at the falling droplets. With this arrangement, the birds soon became sleek and shiny.

The sprinkler also helped with the problem created by heat. Our early worries about cold seem to have been poorly grounded. When the birds were normal with respect to salt intake, they seemed to suffer very little from temperatures as low as 38°F. The Black-footed Albatrosses, however, did show signs of discomfort when the temperature was above 75°F. Instead of sitting with the feet drawn into the feathers, as they usually did, they spread their feet and wings wide. Furthermore, they sought shade, and it was necessary to provide some cover in the outdoor cage for them, as well as to turn on the sprinkler. When the temperatures were above 75°F. at feeding time, the appetites of the Black-foots were severely reduced. On the other hand, the Laysans seemed to have a higher temperature preference than the Black-foots. They sat in the direct sunlight in temperatures up to 85°F., and their appetites were unaffected by high temperatures. They were much less eager to get into the cold water from the sprinkler. In Maine, as soon as the temperature fell below about 55°F., they went into the house. In the turkey pen in Pennsylvania, they sat in the direct beam of the glow heaters, when they were turned on.

These two species of albatrosses are of economic importance because of their habit

of soaring in front of airplanes on Midway Island, thus creating hazards to man and machines. Consequently, any method which could be found to discourage their flying or to repel them might have practical value. Some tests were, therefore, made with suggested "repellents" to see whether any of these would be effective.

As others had noted (Aldrich, 1958; Kenyon *et al.*, 1958), mere loud sounds had little effect on the birds. Pure tones at high intensities, noise bursts, and such natural sounds as loud thunder, all of which are without apparent biological significance to the birds, were ignored. Mere racket was obviously of little concern to them.

It has been suggested that the fear of snakes which some birds have might exist in these birds also. We presented to the albatrosses, at various times and under many circumstances, a number of garter snakes (*Thamnophis* sp.) and a hog-nosed snake (*Heterodon platyrhinos*). At no time did the birds even notice them. The hog-nosed snake struck at the birds as they went by, but they paid absolutely no attention to it. A number of times persons who had dogs or cats brought these near the birds' cage. Except for occasional beak-snaps at the intruders, no more attention was paid to these.

Two chemicals which have been suggested as repellents for pest birds are naphthalene and para-dichlorobenzene. Crystals of these were exposed in pans near the birds at various times under a number of different conditions. Except for interest shown by the birds in anything which resembled their feeding dish, causing them to come and inspect the crystals in the pans, these were ignored.

The birds showed definite rhythmic behavior patterns in captivity, which we were able to follow in Maine, where they were under potentially continuous surveillance. They moved little or not at all at night, although they did not sleep all night. They were active at dawn and for about three hours thereafter, depending upon the weather. When it was rainy or dark, they were active somewhat longer than when it was sunny. From about midmorning until midafternoon, they mostly rested or slept, although there was usually one individual moving about at any time. When it was hot, the sprinkler was turned on at about noon, and they then became very active in bathing and preening. The birds were fed between 5 and 6 p.m. and were usually quite active just before this. After feeding they sat quietly until nearly dark, when they moved about a little, then took their places for the night. In general each had its own preferred spot and, unless disturbed, returned to it each night. If undisturbed, they usually faced toward some object, such as the water container, and thus did not usually soil each other with feces. The two Laysan Albatrosses and one of the Black-footed Albatrosses rested and slept mostly inside the house. The other two Black-foots were rarely inside. When it rained all day, this pattern was disrupted, and the birds generally stayed out in the rain most of the time.

In general, we believe that these albatrosses would be excellent subjects for studies on the behavior and physiology of marine birds. They are large, easy to handle, and extremely docile. They can be easily trained and have predictable patterns of movement. If care is taken to assure that the salt balance is maintained, through regular feeding of salt and observation for dripping from the beak, and if suitable quarters are provided, they seem to be easy to keep in captivity for appreciable periods of time.

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SUMMARY

A study was made of the physiology of the nasal glands and the general behavior of three Black-footed and two Laysan albatrosses which were kept in captivity in Pennsylvania and Maine, after being shipped from Midway Island. Successful maintenance of these birds in captivity requires the provision of sufficient salt. Loss of NaCl by the action of the nasal glands can be reduced by avoidance of stressful situations, such as force-feeding. The bad effects of depression of the sodium level of the blood can be reduced by avoiding the feeding of invertebrate materials, such as squid, which are high in calcium and magnesium, and by feeding only vertebrate foods, mainly fish. Intake of NaCl can be facilitated by providing only sea water for drinking and by feeding salt tablets or capsules imbedded in the food. Normal sodium concentration of the blood can be assayed by feeding NaCl and observing for activity of the nasal glands, as shown by dripping of saline solution from the tip of the beak. If the birds are thus maintained in normal ionic balance, they readily adapt to captivity and train easily to hand feeding. They probably bathe in rain, and this can be satisfactorily simulated by the use of a garden sprinkler. This can also be used as a means for cooling the birds on hot days. They have regular diurnal cycles of behavior, being mostly inactive at night and at midday on sunny days.

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PREMIGRATORY CHANGES IN BODY WEIGHT AND FAT IN WILD AND CAPTIVE MALE WHITE-CROWNED SPARROWS

By JAMES R. KING and DONALD S. FARNER

It is now well established that migratory birds of many species develop large reserves of fat just prior to migration and maintain or periodically replenish these reserves during the migratory period. Indeed, in these species one of the most obvious criteria of the preparedness for migration in spring and fall is the sudden increase in the level of fat reserves. It is perhaps of special significance that sedentary species do not exhibit any analogous autumnal or vernal adiposity, thus emphasizing that intensive fat deposition is an event definitely associated with the migratory habit and presumably a major sign of the metabolic preparation for migration. This contrast has been especially well described for migratory and sedentary forms of *Junco* (Wolfson, 1942), *Fringilla* (de Bont, 1947; Koch and de Bont, 1952), and *Zonotrichia* (Linsdale and Sumner, 1934; Blanchard, 1941; Wolfson, 1945; Odum and Perkinson, 1951). The literature on the phenomenon of premigratory fattening in general has been reviewed by Wachs (1926), Wolfson (1945, 1952), Steinbacher (1951), Schüz (1952), Farner (1955), and Dorst (1956). It would appear that investigation of the external factors and internal mechanisms which initiate and maintain migratory fattening may be a profitable approach to an understanding of the basic physiologic processes in the regulation of migration itself. This paper summarizes some data obtained during the preliminary phases of investigations utilizing this approach. As a primary step in these investigations it was desirable to obtain a quantitative description of the seasonal changes in body weight and body fat in the wild population of White-crowned Sparrows from which the experimental birds were to be obtained. A logical secondary step then consisted of a comparison of the pattern of premigratory fattening in the wild birds and in the captive experimental birds exposed out of doors to natural conditions of temperature and photoperiod. Obviously, if captivity seriously distorts or suppresses the normal response, then the results of experimental studies of premigratory fattening are meaningless in the interpretation of the events which occur under natural conditions. It was our initial objective to determine whether such limitations exist.

MATERIALS AND METHODS

White-crowned Sparrows (*Zonotrichia leucophrys gambelii*) were captured in Japanese mist nets from overwintering populations in the Snake River canyon a few miles south of Pullman, Washington. This population was sampled in the spring until the first week of May, when all birds had vacated the wintering grounds. Captive birds were weighed immediately in the field and those intended for body fat determinations were killed and frozen. Permanent records were made concerning the status of molt and the behavior of the birds in the field. All field data were collected between 11 a.m. and 5 p.m. Experimental birds were returned to the aviaries at Pullman and confined individually in small cages ($22 \times 41 \times 26$ cm.) in an isolated outdoor enclosure. Unless otherwise indicated, the phrase "captive birds" refers to males confined out of doors in these cages. The birds were fed *ad libitum* on a nutritionally adequate chick-starter mash and were weighed at regular, predetermined intervals. Fresh water was always available. Rigorous efforts were made to assure that the birds were disturbed to a minimum extent. Laboratory personnel were in the aviary for only a few minutes daily and the birds were not handled or moved except at 7-day intervals (4 days in 1956) when the cages were cleaned, the body weight determined, and the status of molt, if any, examined. The total ether-soluble lipid in the body was determined by the procedure described by McGreal

and Farner (1956). The results are expressed in terms of a *lipid index*, which denotes the percentage of the body weight composed of ether-extractable fat, and in terms of the *lean body weight* (= fat-free body weight).

RESULTS AND DISCUSSION

Wild birds.—Data obtained from 114 wild males are shown in table 1 and in figures 1 and 2 (lower panel). It is evident that fat deposits decline from a midwinter high and are progressively reduced during the prenuptial molt, attaining a vernal minimum in the period between March 20 and April 10. In mid-April, as the intensity of molt declines, there is apparently a sudden alteration of physiologic status which results in a very intensive storage of fat. Within about 10 days at the end of April the *average* lipid index is more than doubled. For certain individuals this change is even more spectacular, as is suggested by observation of change in weight of captive birds.

Table 1

Variation in Total Weight, Lean Body Weight, and Lipid Index in Male *Zonotrichia leucophrys gambelii* in Late Winter and Spring

Period	Number of birds	Lipid index Mean	Lipid index SD	Body wt. (gms.) Mean	Body wt. (gms.) SD	Lean weight (gms.) Mean	Lean weight (gms.) SD
1. Winter							
1–10 January	2	10.8	.....	27.3	.....	24.4	.....
11–20 January	8	9.8	2.7	27.6	0.8	24.9	0.4
11–20 February	8	7.9	1.4	27.2	0.8	25.0	0.8
2. Prenuptial molt							
1–10 March	8	6.7	0.9	27.6	0.8	25.8	0.8
11–20 March	18	6.0	1.0	28.0	2.1	26.3	1.9
21–31 March	3	6.3	0.5	28.7	1.1	26.9	1.1
1–10 April	23	6.0	0.9	28.4	2.4	26.6	2.2
11–20 April	6	6.7	1.7	27.8	1.2	25.9	0.9
3. Premigration and migration							
21–30 April	32	13.8	5.2	29.2	3.1	25.2	1.5
1–10 May	6	20.2	4.0	32.1	1.8	25.6	0.8

Our data are similar to those obtained by Odum and Perkinson (1951) for the White-throated Sparrow (*Zonotrichia albicollis*) in Georgia. The mean lipid indices for male White-throated Sparrows in several phases of the annual cycle were: midwinter, 12.4; prenuptial molt, 5.6; premigration, 17.2. The premigratory fat deposition was likewise accomplished in 7 to 10 days, beginning in mid-April.

Our data on total weight also agree within about one gram (5 per cent) with those reported by Blanchard and Erickson (1949) and Oakeson (1953) for *Z. l. gambelii* in California and Alaska. These authors also report that the premigratory fattening occurred within about 12 days before departure from the wintering grounds, which began during the second week of April.

A question of considerable interest to us concerns the validity of utilizing variation in total weight as an index of variation in the fat content of the body. Examination of figure 1 will reveal that body weight and lipid index do not vary seasonally in strict proportion to one another. This is the result of concomitant seasonal change in the lean body weight, which begins to increase slowly at the onset of prenuptial molt, attains a maximum during the period of most intense molt, and then declines to approximately its previous value as the molt ceases. Although the mean values of lean body weight for the

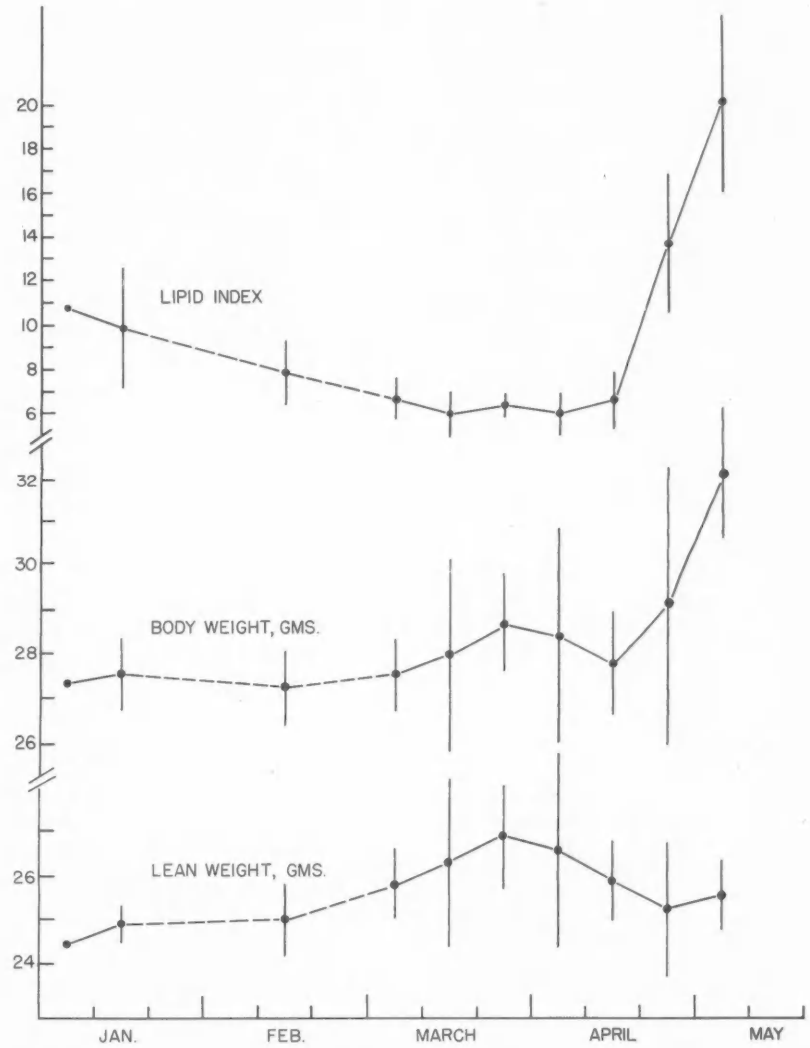

Fig. 1. Variation in mean values for total body weight, lean body weight, and lipid index in wild male *Zonotrichia leucophrys gambelii* in 1952-1953, summarized by 10-day intervals. Vertical bars show the standard deviation of the mean.

intervals shown are not statistically different at the 5 per cent level, the existence of a consistent trend is superficially clear and seems too regular to result from random variation. Furthermore, the close correlation of prenuptial molt and the increase in non-lipid components of the body suggests that the two events share a functional basis. It is feasible that the increase in lean weight results from change in fluid balance and increased storage and turnover of materials required in the keratin synthesis of feather production. We should point out, however, that the data of Odum and Perkinson (1951) on *Zonotrichia albicollis*, although presented somewhat differently than ours, do not reveal any maximum of lean weight during the prenuptial molt. Obviously, additional data are needed before it will be possible to assert definitely whether or not an increase in lean body mass is a normal concomitant of prenuptial molt.

Although the variation in lean body weight described above makes it improper to employ change in total weight as a strict quantitative index of change in fat content, it is evident that this index is entirely adequate for detecting the inception and describing the temporal pattern of premigratory fattening. We have used this procedure in the study of vernal fattening in captive birds.

Captive birds.—Because of the necessity for economy in the use of captive birds, it was not feasible to obtain lipid indices throughout the season. Accordingly, our data relating to premigratory fattening in captive birds consist principally of values for total weight. We also present, however, a few data on the lipid index and lean weight of captive birds sacrificed at the peak of fat deposition.

Table 2

Comparison of Weights of Wild and Captive Male *Zonotrichia leucophrys gambelii*

Period	Weight of captives		Comparison with wild birds	
	Mean	SD	Capt.-wild[1]	Capt./wild[2]
March 1–10	25.9 gm.	1.2	—1.7 gm.	93.9
March 11–20	25.5	1.0	—2.5	91.1
March 21–31	26.2	1.0	—2.5	91.2
April 1–10	26.4	0.8	—2.0	93.0
April 11–20	27.5	2.2	—0.3	99.0
April 21–30	30.2	3.2	+1.0	103.5
May 1–10	32.7	2.2	+0.6	101.9

[1] Difference between means.
[2] Mean weight of captives as a percentage of mean weight of wild birds.

Table 2 compares data from wild and captive birds in 1952–1953. It is evident that during the winter the wild birds are heavier than the captives by an average of about 2 grams. It should be emphasized that we refer here to captives confined to small cages. The difference is smaller (usually less than one gram) if the comparison is made between wild birds and captives kept in large aviaries ($4 \times 2.7 \times 2$ meters) with much flight space (Farner and Wilson, 1957:263). This suggests that the smaller body weight seen in captives may be a function of exercise, with the restriction of exercise by small cages resulting in a decrease in muscular mass. This suggestion is supported by our data on lean body weight of birds confined under different conditions. For 24 males confined out of doors in small individual cages, these data averaged 24.5 grams in late April and early May of 1953–1954. Still greater reduction in lean body weight has been found in experimental male birds confined in small cages indoors. For instance, the mean lean body weight for 24 males subjected to several different daily photoperiods was 23.5 grams at the termination of the experiments. By comparison, the mean lean weight for 38 *wild* males in the period from April 20 to May 10 was 25.5 grams, or one gram more

than for birds confined outside and two grams more than the heterogeneous group of experimentals. All the captive birds mentioned had been in captivity for 4 to 9 months. The duration of captivity was more or less randomly distributed among the various groups of birds mentioned and is not a factor in these comparisons.

It appears from the foregoing that the low body weight observed in late winter in birds confined to small cages out of doors is the result in part of a decrease in the lean weight of the body. However, the average lean weight of captives is approximately only one gram less than that of wild birds, whereas the total body weight of the captives is about *two grams* less than that of wild birds. To account for this difference we must infer that wild birds are slightly fatter than captives during the late winter and early spring. Immediately before migration (April 15–May 10), however, this condition is gradually reversed so that the mean body weight of captives is slightly greater than that of wild birds (table 2). The mean lipid index of 24 captive males sacrificed during this period in 1953–1954 was 26.0. This may be compared with a mean of 20.2 for the wild population during a similar period of 1952–1953.

With regard to the temporal characteristics of vernal fattening in captive birds as compared with wild birds we may note the following. In the wild population in 1952 and 1953, premigratory fat deposition was a very rapid event beginning in the interval from April 11 to 20. The timing and magnitude of the change are most clearly shown in the lower panel of figure 2, where individual data for the lipid index are plotted. A curve drawn through these data would show a strong upward inflection between April 15 and 20. Accordingly, we might select April 18 as a representative, arbitrary date for the onset of vernal fattening. Comparison with the captive birds can be made only on the basis of variation in total weight, individual plots of which are shown in the upper part of figure 2. Although some relatively minor quantitative differences are apparent between the two years, we submit that a curve drawn through these data would exhibit an inflection nearly coincident with that for the wild population. Within the limits of our data it appears that confinement out of doors in small cages does not appreciably affect the timing of fat deposition.

A very interesting temporal feature of vernal fattening is its relatively high precision, both in successive years and among individuals within a given year. We employ the term "precision" here in the statistical sense denoting variance from a central datum, without implication as to the magnitude of variance. Although most of our data on seasonal variation in weight in captive birds were not obtained at sufficiently short intervals to permit a rigorous analysis of temporal precision, they do enable us to make a preliminary appraisal of this. The annual variation in the timing and pattern of vernal fattening is shown in the lower panel of figure 3, where the data on body weight are plotted as deviations from the minimum observed weight in order that all data might be readily shown on a short scale. It is apparent from inspection of this figure that the mean date of inception and the mean rate of development of the fat reserves were very similar during the five years indicated. We have obtained an estimation of the initial date of heavy fat deposition in individual birds by accepting as the most probable date of inception the median date of the four- to seven-day period during which definite fattening was first observed.

By averaging such dates for all the individuals a representative date for the year is obtained. For the period considered in this paper, these dates are: April 19, 1952, April 21, 1953, April 20, 1954, April 17, 1955, and April 13, 1956. For the five years combined, fat deposition began, on the average, on April 19 (57 birds), with a total variation (which was also equal to the standard deviation) of $\pm$ 8 days. Ninety-one per cent of the dates fell within the span of April 10 to 20.

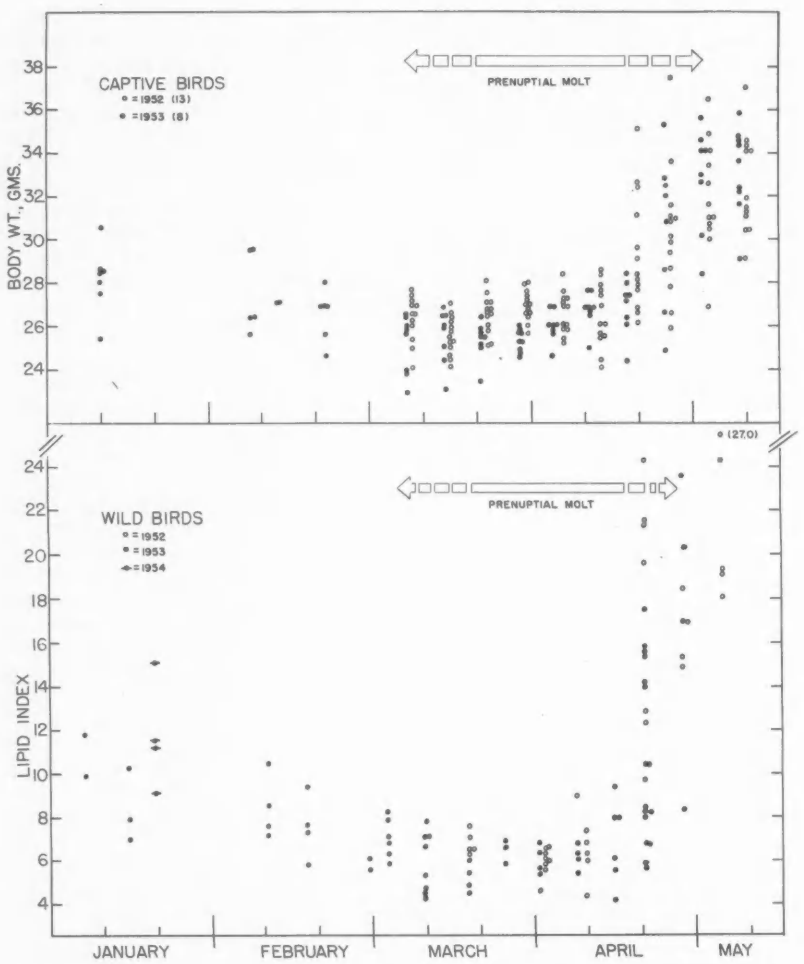

Fig. 2. Individual data on variation in lipid index (wild birds) and body weight (captives, confined out of doors) in male *Zonotrichia leucophrys gambelii*.

We cannot detect any consistent or definite pattern of relationship between the schedule of vernal fattening and the prevailing weather condition. These conditions were highly variable at Pullman during the five years of the study. Mean environmental temperature in March varied from 45 per cent to 118 per cent of normal (based on a 40-year mean); April averages varied from 57 per cent to 121 per cent of the normal. Precipitation in March varied from 38 per cent to 116 per cent, and 11 per cent to 146 per cent in April. It could be argued that the early date (April 13) in 1956 was influ-

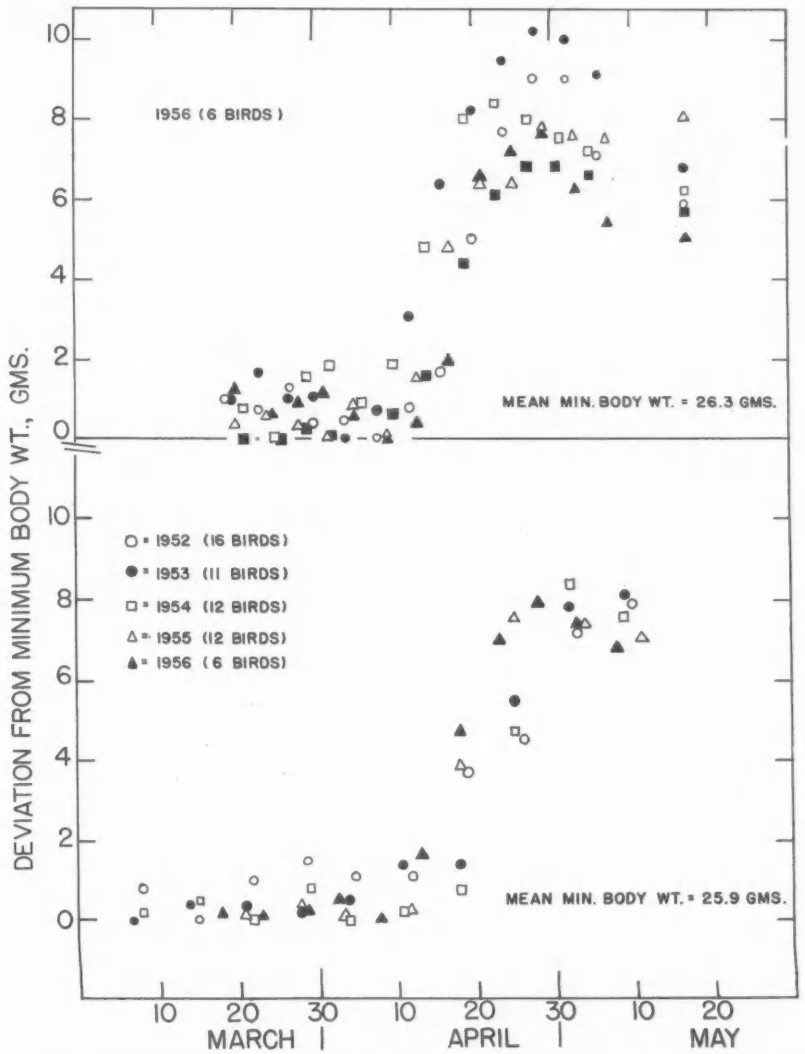

Fig. 3. Upper panel: variation in body weight among individual captive male *Zonotrichia leucophrys gambelii* in 1956; individual data are plotted by four-day intervals. Lower panel: variation in mean body weight in captive male *Z. l. gambelii* confined out of doors. Mean values for the annual groups are plotted by seven-day intervals (four-day intervals in 1956).

enced by warm (114 per cent of normal) and dry (11 per cent of normal precipitation) weather in April. The next earliest index date for the onset of vernal fattening, April 17, 1955, however, occurred in a year characterized in April as cold (mean temperature 57 per cent of normal) and wet (precipitation 146 per cent of normal). In the three other years, in which the index dates for vernal fattening are nearly the same, falling on April 19, 20, and 21, mean temperature in April varied from 76 to 121 per cent of normal and precipitation was between 36 and 93 per cent of normal. On the basis of present evidence we are led to agree with Odum and Perkinson (1951) that climatic conditions appear to affect the schedule of vernal fattening to only a minor degree.

With respect to variation of timing among individuals within a given year, our data for 1956 show that this may be relatively small (upper panel, fig. 3). The mean date for the earliest detectable fattening was April 13, with extremes at ± 3 days. We restrict our discussion of individual variation to this single year because the birds were weighed at four-day intervals, in contrast with seven-day intervals in earlier years, and are accordingly more meaningful in the evaluation of individual variation. Individual variation within the years 1952 to 1955 was not greater than ± 5 days from the median date, and possibly it was less.

In view of the many nutritional, behavioral, and ecological variables which might affect fat and energy metabolism, it appears that temporal variation in vernal fattening in captive birds is remarkably small. Our data from wild birds in 1952–1953 (lower panel, fig. 2), as well as field observations of the Snake River populations in subsequent years strongly suggest that this relative precision prevails also in the wild population.

In conclusion, certain characteristics of vernal fattening place important and useful limitations on hypotheses concerning the etiology of this metabolic adaptation in the White-crowned Sparrow. These include: (1) the apparent year to year precision, (2) the abruptness of the metabolic change, which raises the possibility of a threshold mechanism, and (3) the annual similarity in the rate of fat deposition, even when environmental temperature varied widely from year to year. It has previously been shown in several laboratories that heavy fat deposition can be induced in certain passerines, including the White-crowned Sparrow, by manipulation of the daily photoperiod (Wolfson, 1952, 1954; Koch and de Bont, 1952; Schildmacher and Steubing, 1952; Odum and Major, 1956; King and Farner, 1956). It appears to us that our data are consistent with the hypothesis that vernal increase in the daily photoperiod is the primary timer in the induction of premigratory fattening in the wild population also. Climatic conditions apparently exert only a minor influence over the timing of this important step in the metabolic preparation for migration by *Z. l. gambelii.*

SUMMARY AND CONCLUSIONS

Males of *Zonotrichia leucophrys gambelii* exhibit an abrupt and extensive deposition of body fat in the spring. This adjustment in the level of fat reserves occurs during a span of about 10 days immediately preceding northward migratory movement. On the average, it results in an approximate doubling of the quantity of reserve fat.

Confinement in small cages does not appear to alter appreciably the temporal characteristics of vernal fattening in males of this form. The major effect of captivity consists of an exaggeration of the magnitude of the reserves accumulated during the period of active vernal fattening. In view of the abundant food supply available to captives and the curtailment of their muscular activity this is a predictable difference.

During the prenuptial molt, which occurs undistorted in captive birds, the captives weigh *less* than the wild birds. In part, this results from a loss of lean body weight by captives, presumably as a consequence of the relative disuse and atrophy of the flight

muscles. In addition, we infer that captive birds had smaller fat reserves than wild birds during this period.

Especially interesting characteristics of vernal fat deposition include its typically abrupt inception, precipitant rate of development, and the rather high degree of precision in the timing of annual recurrence. These characteristics appear to be affected to only a minor degree by year to year differences in weather conditions.

Vernal fattening by captive birds exposed to natural environmental temperature and photoperiod is a reasonably good reflection of the event as it occurs in the free-living population. It is evident that the psychological stress of captivity does not interfere with the major regulatory factor or factors which initiate premigratory fattening. We submit that the effects observed in captive birds as a result of experimental manipulation of these factors are therefore meaningful in the interpretation of the regulatory basis of premigratory fattening in wild birds.

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AVIFAUNA OF THE CATEMACO BASIN OF SOUTHERN VERACRUZ, MEXICO

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Rising from the coastal plain of southern Veracruz is a volcanic range known as the Sierra de Tuxtla or Los Tuxtlas (fig. 1). This region is situated in the Veracruz Biotic Province of Goldman and Moore (1945); and although cultivation is underway in many sections of this range, extensive tracts of undisturbed rain forest are still to be found from sea level up to 4000 to 4500 feet, with cloud forest coming in above this altitude. Leopold (1950) refers to the vegetation zone of this area as tropical evergreen forest rather than true rain forest; however, the high annual rainfall of the eastern Catemaco basin (up to 5248 mm.) would indicate that some portions of the Sierra de Tuxtla should be capable of supporting tropical rain forest.

An account of the bird life of a segment of the Tuxtlas range was reported by Wetmore (1943); and since then Firschein (1950), Goodnight and Goodnight (1954), and Firschein and Smith (1956) have written on other aspects of its fauna. All these studies have been limited to the northern portion of this range, principally to the slopes of Volcán San Martín. The investigations have revealed an unusual fauna which can, in all probability, be attributed in part to both the ecological isolation and to the unusual climatic factors. In view of these features, Firschein and Smith (1956) have proposed that the area be designated as a distinct faunal entity, the Catemacan Faunal District, which includes all of the range of the Sierra de Tuxtla above approximately 1000 feet.

Our main purpose in undertaking this study was to learn more of the distribution and population ecology of the avifauna of the Sierra de Tuxtla in a fairly representative locality. Since the village of Coyame on the northeastern shore of Lake Catemaco was roughly centrally located in the Tuxtlas range, we decided to base our operations there from June 28 to July 22, 1954. Our collecting and observations were carried out within approximately a four-mile radius of Coyame at elevations of about 1400 feet with occasional excursions up to 2000 feet.

We wish to acknowledge the courtesy of Mr. John Eiler for making living accommodations available to us during our stay at Coyame. We should also like to thank the authorities of the United States National Museum for the use of their bird collections for comparative material. Almost all of the specimens we collected at Coyame are now in the Carnegie Museum of Pittsburgh. The remaining few are in the George M. Sutton collection at the University of Oklahoma.

CLIMATE

The Lake Catemaco basin opens to the north by a valley to the Gulf of Mexico, thereby permitting the humid air masses from the Gulf ready access into this region. During the months from October to February cold, moist, air masses (nortes) from the Gulf frequently penetrate this region. As these air masses rise, owing to the orography of the Tuxtlas foothills, they very often produce rain. Because of this feature there is no well defined dry season, and the remaining months from March to September are characterized by a rainy season which is favored by the above mentioned orographic lift.

The average yearly rainfall for typical localities within and surrounding the Sierra de Tuxtla were as follows from 1947 to 1953: Coyame, 3781 mm.; Santiago Tuxtla, 2314 mm.; Catemaco, 1963 mm.; San Andrés Tuxtla, 1855 mm.; Alvarado, 1466 mm.; and Acayucan, 1358 mm. From these figures it can be seen that the region around Coyame appears to be a center of high precipitation. During 1952 the annual rainfall

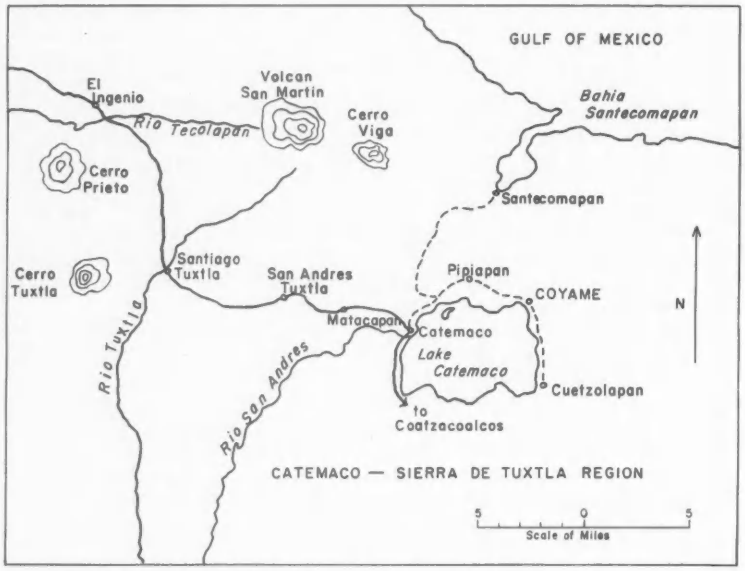

Fig. 1. Outline map showing the Sierra de Tuxtla region of southern Veracruz, México.

reached 5248 mm. at Coyame and 2806 mm. at Catemaco. It is rather remarkable that Coyame should receive about twice as much rainfall as Catemaco which is at a similar altitude some 15 miles to the west.

The average monthly temperatures for 1952–1953 in these two areas were very similar, ranging from a low of 18.5°C. at Coyame and 19.5°C. at Catemaco in January to highs of 26.3°C. at Catemaco and 27.4°C. at Coyame in March.

During our 26-day stay at Coyame, the rainfall averaged about 40 mm. a day, and on 10 of these days it exceeded 60 mm. The temperature remained quite uniform, never dropping below 21°C. or rising above 28°C. A somewhat higher range of 22.8° to 32°C. was recorded from the rain forest of northern Chiapas (Palenque) from July 7 to 20, 1949, by Goodnight and Goodnight (1956). The wind at Coyame was invariably from the northeast.

ECOLOGICAL DISTRIBUTION AND RELATIVE ABUNDANCE

As we planned to confine our study to the avifauna of a rather limited area, it was felt that a descriptive analysis of the relative abundance and distribution of its species could be undertaken. After the first few days at Coyame, the pattern of our trips into the surrounding region was established so that representative habitats were visited over the same trails and approximately between the same hours of the day (8:00 a.m. to 2:00 p.m.). The relative frequency of occurrence of each species was then determined by dividing the number of days it was recorded in a particular habitat by the total number of days spent in observation. All of the frequency data were based on a total of 21 days. Obviously, the abundance of secretive and nocturnal species, as well as some treetop species, could not be adequately estimated by this method.

Rain forest.—The predominant habitat in the vicinity of Coyame was the rain forest, and as would be expected, a large proportion of the resident birds and other animals were closely associated with it.

Situated as it was near the higher mountains of the Sierra de Tuxtla, it was not surprising that the forest of our study area showed a few species usually associated with cloud forest. As Wetmore (1943) suggests, it is apparent that the high and constant rainfall, along with the cold winter air masses which characterize this region, are largely responsible for maintaining the cloud-forest and high rain-forest species at levels down to about 1200 feet. These species, all present in relatively small numbers, included the following:

Odontophorus guttatus, Spotted Partridge
Aulacorhynchus prasinus, Emerald Toucanet
Myadestes unicolor, Slate-colored Solitaire
Catharus mexicanus, Black-headed Nightingale-Thrush
Piranga leucoptera, White-winged Tanager

With the exception of the Chestnut-capped Atlapetes (*Atlapetes brunnei-nucha apertus*), we did not find any of the other unusual species reported by Wetmore (1943) from the upper slopes of Volcán San Martín. The atlapetes was a common resident of the rain-forest understory, even though it was previously known only from above 2500 feet on Volcán San Martín and Cerro Tuxtla (*ibid.*). We found the Slate-colored Solitaire to be rare in our area although it was reported (*ibid.*) as the most common bird on Volcán San Martín.

The birds which seemed to be specifically associated with the interior of the forest (although some of these could often be found near the edge) were as follows, in order of relative frequency of occurrence, excluding the five typical cloud-forest species noted previously:

Species	Frequency (per cent)
Henicorhina leucosticta, White-breasted Wood Wren	100
Turdus assimilis, White-necked Robin	100
Caryothraustes poliogaster, Black-faced Grosbeak	100
Momotus momota, Blue-crowned Motmot	95
Cyanerpes cyaneus, Blue Honeycreeper	95
Habia gutturalis, Rosy-throated Ant-Tanager	95
Amazilia candida, White-bellied Emerald	86
Cyanocorax yncas, Green Jay	86
Habia rubica, Red Ant-Tanager	81
Xiphorhynchus flavigaster, Ivory-billed Woodhewer	76
Automolus ochrolaemus, Buff-throated Automolus	76
Leptotila verreauxi, White-fronted Dove	71
Hylophilus decurtatus, Gray-headed Greenlet	67
Basileuterus culicivorus, Golden-crowned Warbler	62
Amblycercus holosericeus, Prévost Cacique	57
Atlapetes brunnei-nucha, Chestnut-capped Atlapetes	52
Columba nigrirostris, Short-billed Pigeon	48
Trogon violaceus, Gartered Trogon	48
Columba speciosa, Scaled Pigeon	43
Platyrinchus mystaceus, Spade-billed Flycatcher	43
Pipromorpha oleaginea, Oleaginous Pipromorpha	43
Sittasomus griseicapillus, Olivaceous Woodhewer	38
Phaethornis superciliosus, Hermit	33
Trogon collaris, Collared Trogon	33
Hylophilus ochraceiceps, Tawny-crowned Greenlet	33
Cyanocompsa cyanoides, Blue-black Grosbeak	33
Geotrygon montana, Ruddy Quail-Dove	29
Campylopterus hemileucurus, DeLattre Sabre-wing	29
Dendrocincla anabatina, Tawny-winged Woodhewer	29
Xenops minutus, Least Tree-runner	29
Myiobius sulphureipygius, Sulphur-rumped Flycatcher	29
Leucopternis albicollis, White Hawk	24
Lanio aurantius, Shrike-Tanager	24

Species	Frequency (per cent)	Species	Frequency (per cent)
Phaethornis longuemareus, Longuemare Hermit	19	*Rhynchocyclus brevirostris*, Eye-ringed Flat-billed Flycatcher	14
Lepidocolaptes souleyettii, Streaked-headed Woodhewer	19	*Hylomanes momotula*, Tody Motmot	10
Eucometis penicillata, Gray-headed Tanager	19	*Tolmomyias sulphurescens*, Sulphury Flat-billed Flycatcher	10
Crax rubra, Curassow	14	*Oncostoma cinereigulare*, Bent-billed Flycatcher	10
Leptotila plumbeiceps, Gray-headed Dove	14	*Accipiter bicolor*, Bicolored Hawk	5
Celeus castaneus, Chestnut Woodpecker	14	*Pionopsitta haematotis*, Red-eared Parrot	5
Formicarius analis, Black-faced Antthrush	14	*Pipra mentalis*, Yellow-thighed Manakin	5

All the foregoing species with a frequency rating of 50 per cent or greater seemed to be especially successful in meeting the demands of the rain forest. All strata from the ground to the upper tree story were inhabited by one or more of these species; these ranged from such typical ground feeders as *Leptotila verreauxi* and *Atlapetes brunneinucha* to *Hylophilus decurtatus* and *Caryothraustes poliogaster* of the treetops. These 16 abundant species showed a variety of nesting habits, but none built a hanging nest with a thatched roof, which would seem to be the most advantageous type. None fed on flying insects to any great extent.

Within the rain forest the feeding activities of the birds were governed largely by the duration of the rain showers. On many days there seemed scarcely a moment when the birds could feed uninterrupted by moderate to heavy rain. On other days, when the rains were not excessive, the birds were noticeably active between showers. Many of the nests that we found were built in holes or under some overhanging object, or else they were roofed over. Selection in such an environment must favor those types which can find food easily during the brief lulls in the rain as well as those which build well-sheltered nests.

The following facts regarding the birds associated with the interior of the rain forest were evident. Birds of prey were not common. Pigeons and doves were numerous and varied, either seed eaters of the forest floor or fruit eaters of the uppermost canopy. Only one small flock of parrots was seen on one occasion. Hummingbirds were more abundant and varied in the forest than in the forest edge or open fields. Woodhewers were much more common than woodpeckers, and the only woodpecker restricted largely to the interior of the forest, *Celeus castaneus*, was not common. The Tropical Pileated Woodpecker and the Guatemalan Ivory-billed Woodpecker, usually reasonably common in somewhat similar situations in other areas, were not observed. Six kinds of flycatchers occurred here, but were far less numerous than their close relatives in the forest edge and open fields. None of the other groups was represented by more than three species except the tanagers with two abundant and three uncommon species.

Interspecies flocking.—In a study of eight loose flocks of birds observed in the rain forest in mid-July, only two consisted entirely of interior rain-forest species; the other six included some forest-edge species as well. However, the nuclear species of these flocks seemed to be interior rain-forest birds such as *Caryothraustes poliogaster* of the high forest, *Xiphorhynchus flavigaster* of the middle and lower levels, and *Automolus ochrolaemus* and *Henicorhina leucosticta* of the low trees and shrubs. All these were noisy and active birds, and each of them was to be found in some five of the eight flocks. None of the flocks contained fewer than two of these species. Other species which could be found in as many as three of the eight flocks were: *Habia gutturalis, Basileuterus culicivorus, Turdus assimilis,* and *Cyanerpes cyaneus*; all are interior forest species. Thirty-four other species were associated with one or another of the flocks as circumferential

Fig. 2. Rain forest and cleared field bordering Lake Catemaco at Coyame.

species, and several of these were characteristic species of the forest edge. The most common of these apparently circumferential forms included: *Hylophilus decurtatus, Habia rubica, Lanio aurantius, Hylophilus ochraceiceps, Myiarchus tuberculifer, Piprомorpha oleaginea, Cyanocorax yncas,* and *Trogon violaceus* (see frontispiece, opposite p. 305), and some of these may actually have been serving as nuclear species on some occasions. The remaining forms did not appear to be instrumental in forming any of the observed flocks.

The two ant-tanagers, *Habia rubica* and *H. gutturalis,* were never observed together in the same flock unless other species of birds were present. These ant-tanagers could be readily distinguished in interspecies flocks by their calls, the chatter of *H. gutturalis* being slower, lower in pitch, and much more rasping than that of *H. rubica.*

Forest edge.—The edge of the rain forest seemed to provide a suitable habitat for many species which seldom penetrated far into the forest and likewise were not well adapted for life in the open fields. Some of these birds also occurred in hedgerows or patches of second growth, although others did not frequent such places. These forest-edge species were perhaps influenced even more by the heavy rains than were the interior forest birds, since many of them fed on flying insects. The following list indicates occurrence and relative abundance of distinctively forest-edge species:

Species	Frequency (per cent)
Columbigallina talpacoti, Talpacoti Dove	100
Campylopterus curvipennis, Sabre-wing	100
Centurus aurifrons, Golden-fronted Woodpecker	100
Myiozetetes similis, Vermilion-crowned Flycatcher	100
Thryothorus maculipectus, Spotted-breasted Wren	100
Turdus grayi, Clay-colored Robin	100
Dives dives, Sumichrast Blackbird	100
Tyrannus melancholicus, Tropical Kingbird	95
Ramphastos sulfuratus, Keel-billed Toucan	90
Myiarchus tuberculifer, Olivaceous Flycatcher	90
Thraupis abbas, Abbot Tanager	90
Saltator atriceps, Black-headed Saltator	90
Columba flavirostris, Red-billed Pigeon	86
Claravis pretiosa, Blue Ground Dove	86
Pitangus sulphuratus, Kiskadee Flycatcher	86
Vireo olivaceus, Red-eyed Vireo	86
Myiodynastes luteiventris, Sulphur-bellied Flycatcher	81

Species	Frequency (per cent)
Megarhynchus pitangua, Boat-billed Flycatcher	81
Gymnostinops montezuma, Montezuma Oropendola	81
Saltator coerulescens, Gray Saltator	81
Arremonops rufivirgata, Olive Sparrow	76
Tityra semifasciata, Masked Tityra	70
Phlogothraupis sanguinolenta, Crimson-collared Tanager	70
Elaenia flavogaster, Yellow-bellied Elaenia	67
Tanagra lauta, Thick-billed Euphonia	62
Piculus rubiginosus, Red-capped Green Woodpecker	57
Synallaxis erythrothorax, Rufous-breasted Spinetail	57
Myiarchus tyrannulus, Wied Flycatcher	57
Campylorhynchus zonatus, Banded-backed Wren	48
Piaya cayana, Squirrel Cuckoo	43
Ramphocaenus rufiventris, Long-billed Ant-wren	43
Nyctidromus albicollis, Parauque	38
Thraupis virens, Blue-gray Tanager	38
Amazilia tzacatl, Rieffer Hummingbird	33
Troglodytes musculus, Southern House Wren	33
Basileuterus rufifrons, Rufous-capped Warbler	33
Psilorhinus morio, Brown Jay	29
Tangavius aeneus, Red-eyed Cowbird	29
Buteo nitidus, Gray Hawk	24
Falco albigularis, White-throated Falcon	24
Ortalis vetula, Common Chachalaca	24
Richmondena cardinalis, Cardinal	24
Buteo magnirostris, Insect Hawk	19
Contopus cinereus, Tropical Pewee	19
Icterus prosthemelas, Black-cowled Oriole	19
Centurus pucherani, Pucheran Woodpecker	14
Thamnophilus doliatus, Barred Antshrike	14
Attila spadiceus, Polymorphic Attila	14
Scardafella inca, Inca Dove	10
Crotophaga sulcirostris, Groove-billed Ani	10
Veniliornis fumigatus, Smoky-brown Woodpecker	10
Legatus leucophaius, Pirate Flycatcher	10
Aimophila rufescens, Rusty Sparrow	10
Buteogallus anthracinus, Crab Hawk	5
Columbigallina minuta, Plain-breasted Ground Dove	5
Glaucidium brasilianum, Streaked Pygmy Owl	5
Platypsaris aglaiae, Rose-throated Becard	5
Myiodynastes maculatus, Streaked Flycatcher	5
Icterus mesomelas, Yellow-tailed Oriole	5

Stratification as to forest level was much less pronounced along the forest edge than in the forest, with fewer species strongly associated with any particular stratum. Among the Columbidae there was the contrast between the ground-feeding *Columbigallina talpacoti* and the treetop *Columba flavirostris*, but in most families the birds ranged regularly from near the ground to the treetops. Most of the birds of prey were in this type of habitat and doubtless found hunting more rewarding in such relatively open areas. Pigeons and doves were at least as numerous here as within the forest. The Golden-fronted Woodpecker (*Centurus aurifrons*) and the Red-capped Green Woodpecker (*Piculus rubiginosus*) showed frequencies of 100 and 57 per cent, respectively, in contrast to the rarity of woodpeckers inside the rain forest. At least six species of flycatchers were abundant in the forest edge, and several others occurred there in lesser numbers. This was easily the predominant family of the forest edge, and there was no group within the forest which had so many species in abundance. Seven kinds of these forest-edge flycatchers habitually rear their young in tree holes, roofed hanging nests, or globular nests with side entrances; however, some of these species were not as numerous as others which had open-topped, bowl-shaped nests. It is somewhat surprising that the Yellow-bellied Elaenia, which was abundant in the present study, was found by Wetmore (1943) to be exceedingly rare. Among the wrens, thrushes, and vireos, *Thryothorus maculipectus*, *Turdus grayi*, and *Vireo olivaceus* were abundant. The Icteridae, Thraupidae, and Fringillidae were each represented by several species, and usually at least two of these were abundant. Wetmore (1943) lists the Montezuma Oropendola (*Gymnostinops montezuma*) and the Black-cowled Oriole (*Icterus prosthemelas*) as rare around Tres

Zapotes. *Icterus prosthemelas* was likewise uncommon in our study area; *G. montezuma*, however, was an abundant forest-edge species.

Open fields.—In the few open fields which had been cleared and were being used for pasture, only the following four species occurred in regular association with the grassland:

Species	Frequency (per cent)	Species	Frequency (per cent)
Sporophila torqueola, White-collared Seedeater	100	*Volatinia jacarina*, Blue-black Grassquit	57
Tiaris olivacea, Yellow-faced Grassquit	95	*Chamaethlypis poliocephala*, Ground Chat	48

Lake and shore.—Twelve species were noted regularly associated with the lake, its shore, and nearby marshes, as follows:

Species	Frequency (per cent)	Species	Frequency (per cent)
Ceryle torquata, Ringed Kingfisher	100	*Chloroceryle amazona*, Big Green Kingfisher	29
Phalacrocorax olivaceus, Olivaceous Cormorant	86	*Iridoprocne albilinea*, Mangrove Swallow	24
Butorides virescens, Little Green Heron	76	*Pelecanus occidentalis*, Brown Pelican	5
Podilymbus podiceps, Pied-billed Grebe	52	*Leucophoyx thula*, Snowy Egret	5
Chloroceryle americana, Little Green Kingfisher	48	*Jacana spinosa*, Jacana	5
		Larus atricilla, Laughing Gull	5
		Sayornis nigricans, Black Phoebe	5

Although some fledgling Little Green Herons (*B. virescens*) were seen, the marshes in our study area did not appear to support a large number of characteristic marsh species.

Wide ranging forms.—The King Vulture (*Sarcoramphus papa*), Black Vulture (*Coragyps atratus*), Turkey Vulture (*Cathartes aura*), and Vaux Swift (*Chaetura vauxi*) ranged widely over all of the major habitats. Black Vultures were observed many times feeding on a dead cow in an open field near the lake; the other two species of vultures, however, were never seen to feed. No nests of these wide-ranging birds were located.

MISCELLANEOUS NOTES

The following is a discussion of the nesting, behavior, and taxonomy of selected species.

Columba nigrirostris. Short-billed Pigeon. Although moderately common, this pigeon did not appear in flocks. It called persistently from the rain forest, a soft *waddle, wat-wat-waddle.*

Claravis pretiosa. Blue Ground Dove. Belying its name, this dove usually called from the tops of high trees. Its call, a low-pitched *hoot,* was sometimes given in loose combinations of two.

Geotrygon montana montana. Ruddy Quail-Dove. An occupied nest was found on July 19, a light structure of sticks and dead leaves located about five feet from the ground on an almost horizontal section of a large bent tree trunk (fig. 3). The nest varied in depth from two inches on the lower side, to the thickness of a leaf on the upper side. One of the two pale flesh-colored eggs measured 31 by 23 mm. It was possible to approach to within about six feet of the nest before the incubating bird would leave. The bird sat with its tail feathers held tightly together and pointed almost vertically upward (fig. 4). It was interesting to note that the bird turned to keep its tail toward the observer, as one walked around the nest. The first nestling hatched on the third day of observation (July 22) and was covered with pale buff down. The second egg was pipped at this time. Wetmore (1943) reports a breeding male on May 9 from Tres Zapotes.

Phaethornis superciliosus veraecrucis. Hermit. This hummingbird had the habit of frequently hovering directly in front of the observer, at which time the long central tail feathers were usually held together.

Phaethornis longuemareus adolphi. Longuemare Hermit. The behavior of this species is much like that of *P. superciliosus*.

Campylopterus curvipennis excellens. Sabre-wing. In large head size, thickness of bill, and long tail, our specimens are quite distinct from other individuals of this species from other portions of its range. It seems more likely, however, that this form is a well-marked subspecies rather than a separate species. In behavior, including its bubbling call, it appears indistinguishable from *C. curvipennis* in other parts of its range.

Fig. 3. Nest of the Ruddy Quail-Dove (*Geotrygon montana montana*) soon after first egg hatched.

Fig. 4. Nest of the Ruddy Quail-Dove showing characteristic posture of incubating bird when disturbed.

Campylopterus hemileucurus hemileucurus. DeLattre Sabre-wing. A nest with two young was discovered in a narrow ravine on July 12. The nest was saddled on two palm leaf petioles at the point where they crossed each other. It was cup-shaped and constructed almost entirely of trailing moss plus a few small plant stems and rootlets inside the cup. The diameter of the nest was 45 mm. on the inside and 70–100 mm. on the outside, while the cup was 25 mm. deep inside and roughly 50 mm. outside with several loose strands of moss and rootlets hanging down. The nest was protected from above by an overhanging leaf and a rock wall.

Amazilia tzacatl tzacatl. Rieffer Hummingbird. A nest of this hummingbird, constructed of buff-colored plant down and covered on the outside with lichens, was found on July 8. It was situated about five feet above ground in the crotch of a shrub (fig. 5) at the forest edge. The nest was 22–25 mm. deep inside and 43 mm. outside. Its inside and outside diameters were 28 and 40–42 mm., respectively. Wetmore (1943) discovered a nest with eggs of this species on April 2 in heavy forest.

Automolus ochrolaemus cervinigularis. Buff-throated Automolus. This abundant ovenbird of the rain-forest understory had a great variety of calls, from a high-pitched whinny or loud, full trill to a musical *quirt* and a rasping *cr-a-a-k*.

Formicarius analis moniliger. Black-faced Antthrush. The song of this secretive antbird was a series of musical notes, mostly on one pitch, but with the last two or three notes on a higher pitch. Its alarm note was a loud *pul-lawt* or *pu-tewt*. The bird walked along the ground with its tail pointing up.

Pipra mentalis mentalis. Yellow-thighed Manakin. Its song was a long high-pitched note, sliding up and then down the scale, preceded by some quiet chips and succeeded by a rather loud *pit*.

Sayornis nigricans nigricans. Black Phoebe. One specimen, an immature male, taken on July 20 at lake level, was unexpected at such a low elevation.

Myiobius sulphureipygius sulphureipygius. Sulphur-rumped Flycatcher. The actions of this fly-

catcher were reminiscent of those of a redstart, and the yellow flash of the rump heightened the impression of similarity to *Setophaga ruticilla*. It was not seen to make any sorties into the air for flying insects.

Platyrinchus mystaceus cancrominus. Spade-billed Flycatcher. Noted in dense thickets, or in more open areas within the rain forest close to the ground. It often sat quietly, but when calling it could be readily located. The call was a rather rasping, petulant *pit-di-di-dit*, or *pit-di-dit*, with the first note sharply accented. Frequently the bird would quickly reverse its position on a twig just before flying off to a new perch.

Fig. 5. Nest of the Rieffer Hummingbird (*Amazilia tzacatl*).

Tolmomyias sulphurescens. Sulphury Flat-billed Flycatcher. Although no specimens were obtained, one pair was observed feeding young in its hanging, enclosed nest. The nest was much farther above the ground (approximately 40 feet) than any other nests of this species previously observed by us.

Elaenia flavogaster subpagana. Yellow-bellied Elaenia. This flycatcher behaved at times somewhat like a robin, flying rather rapidly for some distance, perching in the branches of large fruit trees, and actively feeding on small drupes. At other times its actions and calls were like those of a Tropical Kingbird (*Tyrannus melancholicus*) on a more subdued scale. Its usual call was a slow, rasping *wee-e-e-r*, much like that of the Western Wood Pewee (*Contopus richardsonii*).

Pipromorpha oleaginea assimilis. Oleaginous Pipromorpha. The actions of this species were often more like those of a vireo than of a conventional flycatcher. In a forest ravine, on July 12, a nest was found hanging from a small root which stuck out from a low cliff about 16 feet above a stream bed. The root was so flexible that the weight of the nest made it extend straight down with the nest resting against the cliff. The nest was an enclosed structure with a side entrance, the outer shell consisting

almost entirely of straight, slender plant runners, many of which were still growing in the humid environment. Three pure white eggs were in the nest. One of these eggs measured 22 by 15 mm. The incubating bird remained on the eggs until approached to within about three feet. Wetmore (1943) records breeding birds of this species between March 29 and April 21 from the Sierra de Tuxtla.

Campylorhynchus zonatus zonatus. Banded-backed Wren. Our one specimen differs from all specimens of *C. z. restrictus* from southern Veracruz in the United States National Museum except for one from San Andres Tuxtla. The individuals from the Sierra de Tuxtla are probably intergrades between *restrictus* and *zonatus* (Pac. Coast Avif. No. 33, 1957:150).

Myadestes unicolor unicolor. Slate-colored Solitaire. An occupied nest was discovered on July 12, in the same low cliff which held the nest of *Pipromorpha oleaginea.* The solitaire's nest was made like that of a phoebe, constructed partially of mosses and set in a little niche in the cliff about 12 feet above stream level. When flushed from its nest, the incubating bird flew to a perch nearby and sang. A specimen from the Sierra de Tuxtla in the United States National Museum was nesting on May 12.

Ramphocaenus rufiventris rufiventris. Long-billed Ant-wren. This inconspicuous ant-wren frequented dense thickets and was rarely seen except when singing. Its song was a musical trill, sometimes rising or falling in pitch toward the end.

Hylophilus ochraceiceps ochraceiceps. Tawny-crowned Greenlet. The usual song of this vireo was quite different from that of *Hylophilus decurtatus,* being usually an ascending trill followed by a lower-pitched single note.

Thraupis abbas. Abbot Tanager. A pair nested about 12 feet from the ground in an orange tree. The parents often came to the nest, which contained young, without any obvious food in their bills.

Habia gutturalis salvini. Rosy-throated Ant-Tanager. Judging from one of our specimens and a few in the United States National Museum, some males of this species come into breeding condition before molting into the full red adult plumage. A breeding male (May 9) in immature plumage is also recorded by Wetmore (1943) from the Sierra de Tuxtla.

Lanio aurantius aurantius. Shrike Tanager. This uncommon bird of the heavy forest had a wide variety of calls and songs, one of the calls closely resembling the several-noted call of the Summer Tanager (*Piranga rubra*).

Eucometis penicillata pallida. Gray-headed Tanager. Its call note is a high-pitched *chewt.* The bird is somewhat thrush-like in its actions, standing high on its legs, and flicking its tail and wings nervously. It usually frequented the heavy forest undergrowth.

Saltator atriceps suffuscus. Black-headed Saltator. All of our adult specimens are comparable to material in the United States National Museum from Tres Zapotes, Veracruz, showing the buffy-brownish throat color. One of the immature males has the lower mandible, tomium, and terminal portion of the upper mandible yellowish buff, and the throat largely whitish. A nest occupied by two nestlings was discovered on July 21 in a partly overgrown field. It was located about eight feet above the ground in the crotch of a small tree and was constructed mainly of twigs and lined with small vines. The nest measured approximately nine by five inches across and five inches deep on the outside, and it was four by three inches across and two and a half inches deep on the inside.

Cyanocompsa cyanoides concreta. Blue-black Grosbeak. One of our male specimens was a subadult, largely dark brown, but with some blue-black feathers coming in. Its call was a metallic clinking note, reminiscent of that of the Tropical Pileated Woodpecker (*Dryocopus lineatus*). Several notes were given in succession at times.

Tiaris olivacea pusilla. Yellow-faced Grassquit. A nest of this grassquit was located on July 8, about a foot from the ground between weed stems in a pasture. It was ovoid in shape and completely enclosed except for a side entrance. The eggs were white with brownish vermiculations.

Atlapetes brunnei-nucha apertus. Chestnut-capped Atlapetes. Individuals were collected in various stages of development, including one stub-tailed fledgling. These young birds did not differ markedly from the young of other races of *A. brunnei-nucha* in comparable stages (Parkes, 1957). The call note of the adult is a very high-pitched *zeet,* and the song is a series of high-pitched notes. What appears to be the first known nest of *A. b. apertus* was discovered on July 21. The adult bird was flushed from the nest (fig. 6), which was situated about seven and a half feet above the ground in the center of a small chocha palm in the heavy forest. The nest was an open cup made almost entirely of leaves with a few twigs woven in, and the cup was lined with rootlets. The entire structure was eight and a half

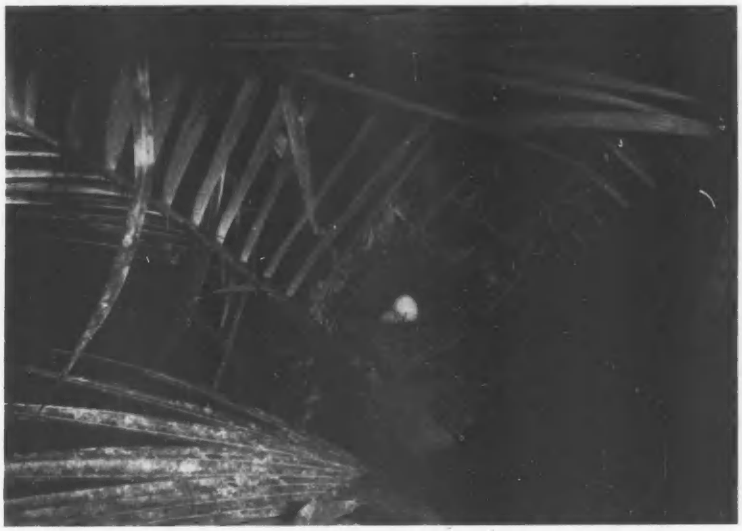

Fig. 6. Nest of the Rufous-capped Atlapetes (*Atlapetes brunnei-nucha apertus*) in chocha palm.

inches high and five inches wide outside and three and a half inches wide and two inches deep inside. There were two stubby, pure white eggs measuring approximately 20 by 15 mm.

SYSTEMATIC LIST

The following is a complete list of all forms collected or observed. Of the 134 species found in our study area around Coyame, 72 forms or about 54 per cent were common to Wetmore's list (1943) from Volcán San Martín and Cerro Tuxtla. Fifteen species, however, had not previously been recorded from the Sierra de Tuxtla, and these are designated with an asterisk.

The breeding condition of the birds is indicated as either gonads markedly enlarged (GE) or nesting (N), where applicable.

**Podilymbus podiceps*
Pelecanus occidentalis
Phalacrocorax olivaceus
Fregata magnificens
Butorides virescens virescens
**Leucophoyx thula*
Sarcoramphus papa
Coragyps atratus
Cathartes aura
**Accipiter bicolor fidens*
Buteo magnirostris
Buteo nitidus
Leucopternis albicollis ghiesbreghti
Buteogallus anthracinus
Falco albigularis
Crax rubra
Ortalis vetula
Odontophorus guttatus
Jacana spinosa
Larus atricilla
Columba flavirostris flavirostris
**Columba speciosa*
Columba nigrirostris
Scardafella inca
Columbigallina talpacoti rufipennis (GE)
Columbigallina minuta interrupta (GE)
**Claravis pretiosa* (GE)
Leptotila verreauxi fulviventris
Leptotila plumbeiceps plumbeiceps (GE)
Geotrygon montana montana (N)
**Pionopsitta haematotis haematotis*
Piaya cayana thermophila
Crotophaga sulcirostris sulcirostris
Glaucidium brasilianum ridgwayi

Nyctidromus albicollis yucatanensis
**Chaetura vauxi*
Phaethornis superciliosus veraecrucis
Phaethornis longuemareus adolphi
Campylopterus curvipennis excellens
Campylopterus hemileucurus hemileucurus (N)
Amazilia candida candida
Amazilia tzacatl tzacatl (N)
Trogon collaris puella
Trogon violaceus braccatus
Ceryle torquata
Chloroceryle amazona
Chloroceryle americana septentrionalis
Hylomanes momotula momotula
Momotus momota lessonii
Aulacorhynchus prasinus prasinus (GE)
Pteroglossus torquatus torquatus
Ramphastos sulfuratus
Piculus rubiginosus yucatanensis
Celeus castaneus
Centurus aurifrons veraecrucis
**Centurus pucherani perileucus*
Veniliornis fumigatus sanguinolentus
Dendrocincla anabatina anabatina
Sittasomus griseicapillus sylvioides
Xiphorhynchus flavigaster eburneirostris
**Lepidocolaptes souleyettii insignis*
Synallaxis erythrothorax furtiva
Automolus ochrolaemus cervinigularis (GE)
Xenops minutus mexicanus
Thamnophilus doliatus intermedius
Formicarius analis moniliger (GE)
Attila spadiceus flammulatus
Platypsaris aglaiae sumichrasti
Tityra semifasciata personata (GE)
**Pipra mentalis mentalis* (GE)
**Sayornis nigricans nigricans*
Tyrannus melancholicus chloronotus (N)
Legatus leucophaius variegatus
Myiodynastes luteiventris luteiventris
Myiodynastes maculatus insolens (GE)
Megarynchus pitangua mexicanus
Myiozetetes similis texensis
Pitangus sulphuratus derbianus
Myiarchus tuberculifer lawrencei
**Contopus cinereus brachytarsus* (GE)
Myiobius sulphureipygius sulphureipygius
Platyrinchus mystaceus cancrominus
Tolmomyias sulphurescens cinereiceps (N)
**Rhynchocyclus brevirostris brevirostris*
Oncostoma cinereigulare
Elaenia flavogaster subpagana (GE)
Pipromorpha oleaginea assimilis (N)
Iridoprocne albilinea
Cyanocorax yncas
Psilorhinus morio
Campylorhynchus zonatus zonatus
Thryothorus maculipectus maculipectus
**Troglodytes musculus intermedius*
Henicorhina leucosticta prostheleuca
Turdus assimilis leucauchen (GE)
Turdus grayi grayi (GE)
Catharus mexicanus mexicanus (GE)
Myadestes unicolor unicolor (N)
Ramphocaenus rufiventris rufiventris (GE)
Vireo olivaceus flavoviridis
Hylophilus ochraceiceps ochraceiceps
Hylophilus decurtatus decurtatus (GE)
Cyanerpes cyaneus cyaneus (GE)
Seiurus motacilla
Chamaethlypis poliocephala caninucha (GE)
Basileuterus culicivorus culicivorus
Basileuterus rufifrons salvini
Gymnostinops montezuma
Amblycercus holosericeus holosericeus
Tangavius aeneus
Dives dives dives
Icterus prosthemelas prosthemelas (GE)
Icterus mesomelas mesomelas
Tanagra lauta lauta (GE)
Thraupis virens diaconus
Thraupis abbas (N)
Phlogothraupis sanguinolenta sanguinolenta
Piranga leucoptera leucoptera
Habia rubica rubicoides (GE)
Habia gutturalis littoralis (GE)
Lanio aurantius aurantius
Eucometis penicillata pallida
Saltator atriceps suffuscus (N)
Saltator coerulescens grandis
Caryothraustes poliogaster poliogaster
Richmondena cardinalis coccinea
Cyanocompsa cyanoides concreta (GE)
Tiaris olivacea pusilla (N)
Sporophila torqueola morelleti (GE)
Volatinia jacarina splendens (GE)
Atlapetes brunnei-nucha apertus (GE, N)
Arremonops rufivirgatus crassirostris (GE)
**Aimophila rufescens pyrgitoïdes*

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A CONDOR FROM THE UPPER PLIOCENE OF KANSAS

By HARRISON B. TORDOFF

Until recently, vulture remains were absent from the collection of several hundred fossil avian bones collected over the past twenty years by Claude W. Hibbard and his associates in Kansas. This gap in the otherwise fairly complete Rexroad avifauna of the Upper Pliocene was filled in the summer of 1958, when Hibbard's party found a tarsometatarsus in nearly perfect condition. The bone is that of an undescribed American vulture which was larger than a modern King Vulture (*Sarcoramphus papa*) but smaller than a California Condor (*Gymnogyps californianus*). The fossil and Recent species of the Cathartidae are well known through the careful work of Loye Miller, Hildegarde Howard, and Harvey I. Fisher, whose researches provide a sound basis for study of this new vulture.

The Rexroad species appears to parallel *Teratornis merriami* in some respects. Nevertheless, it clearly belongs to the Cathartidae rather than to the Teratornithidae because it has the following distinctively cathartid characteristics (Miller and Howard, 1938: 169): Facet for metatarsal I faces posterolaterally rather than posteriorly as in Teratornithidae; intercotylar tuberosity high and conspicuous, not low and rounded; hypotarsal block not as symmetrically quadrangular as in Teratornithidae and separated from head of tarsometatarsus by a narrow groove, rather than by a broad, smooth depression; excavation of shaft on anterior face below head deep and sharply vaulted proximally, instead of blending into head as in Teratornithidae (*Cathartes*, however, resembles the Teratornithidae in this respect, rather than its relatives in the Cathartidae).

Although the Rexroad tarsometatarsus is certainly cathartid, it differs from other known genera of the family at least as much as they differ from each other. For this reason it is here assigned to a new genus and species.

Pliogyps new genus

Type.—Pliogyps fisheri new species.

Diagnosis.—Agrees with Cathartidae and differs from Teratornithidae as described above. Differs from other cathartid genera in relatively huge trochlea for digit III; proximal articular surface of tarsometatarsus large and shaft thick in comparison to length of bone; general form of tarsometatarsus columnar, with symmetrical lateral flaring both proximally and distally; shaft less deeply and extensively excavated anteriorly than in *Cathartes, Coragyps, Sarcoramphus, Vultur,* or *Gymnogyps,* resembling *Breagyps* in this respect except that excavation is relatively narrower in *Breagyps*; hypotarsus merges distally into shaft by means of a broad, rounded ridge in contrast to narrower ridge in other cathartids (some specimens of *Breagyps* approach *Pliogyps* in this regard); groove of trochlea for digit III ends anteroproximally in shallow but distinct pit—this is variable in other vultures at hand but only some *Cathartes* equal the condition in *Pliogyps.*

Discussion.—Phasmagyps Wetmore (1927) from the Oligocene of Colorado is known only from part of a tibiotarsus. It seems to be closest to *Coragyps* and thus is not related on a generic level to *Pliogyps.*

Palaeogyps Wetmore (1927), also from the Colorado Oligocene, is known from the lower part of a tibiotarsus (type) and the proximal third of an associated tarsometatarsus. Wetmore considered it to be a small condor; it is somewhat smaller than *Pliogyps* and shows differences which are certainly of generic value. In *Palaeogyps,* the hypotarsus is narrow and long (equal in length to the width of the shaft at the level of the distal end of the hypotarsus); in *Pliogyps* the hypotarsus is broad and short (only half as long as the width of the shaft at this level). The posterior surface of the hypotarsus is divided by a ridge in *Pliogyps* and is undivided in *Palaeogyps.* The proximal articular surfaces of *Palaeogyps* differ considerably from those of *Pliogyps* in shape and size.

Although the foregoing do not constitute a complete list of differences, they suffice to preclude close relationship between *Palaeogyps* and *Pliogyps*.

Cathartidarum Winge (1888) is known from a Pleistocene humerus from Brazil. It was about the size of *Coragyps* and seems to have been related to *Sarcoramphus* (Miller, 1931:71).

Another fossil vulture requiring consideration is *Sarcoramphus kernense* (Miller, 1931), from the middle Pliocene of California. This species is represented by the distal part of a humerus which differs from that of the modern King Vulture in being larger, more robust, and relatively shorter. Although the humerus of *Pliogyps* is unknown, it also can be confidently assumed to have been larger and relatively more robust than in *S. papa*.

As discussed later, *Pliogyps* is suggestive of *Teratornis merriami* in proportions of the tarsometatarsus. If one assumes that the humerus would have the same relationship to the length of the tarsometatarsus in *Pliogyps* as it does in *Teratornis*, then a simple calculation shows that the transverse diameter of the distal end of the humerus in *Pliogyps* might be approximately 42 mm., whereas it is 38.7 mm. in *S. kernense*. If the assumption is made that tarsal length in *S. kernense* would have the same relationship to humeral size as occurs in *S. papa*, then the computed tarsal length of *kernense* is 111 mm. versus 94 mm. in *Pliogyps*. Finally, if it is assumed that *S. kernense* has the proportions of *T. merriami*, then the computed length of tarsometatarsus for *kernense* is 89 mm., as compared to 94 mm. in *Pliogyps*. These computations prove nothing. They do, however, provide some additional basis for my admittedly subjective opinion that the humerus of *S. kernense* and the bone here described as *Pliogyps* do not represent the same species.

Both *Sarcoramphus kernense* and *Pliogyps* are from the Pliocene, which fact perhaps increases the possibility that they might be conspecific. However, *Pliogyps*, apart from size, is as different from *S. papa* as from any other cathartid. There is no doubt that it is generically distinct from *Sarcoramphus*, and it seems probable that the humerus would also show distinctive generic characteristics, although Fisher (1944:294) states that there are only slight generic differences between cathartids in the distal portion of the humerus. If associated material is ever found which proves *S. kernense* and *Pliogyps* to be identical, then *kernense* must be transferred from *Sarcoramphus* to *Pliogyps* on the basis of the distinctive characteristics of the tarsometatarsus.

Vultur fossilis (= *Sarcoramphus fossilis* Moreno and Mercerat, *1891:27*, pl. *18*), from the Pleistocene of Argentina, is thought by Fisher (1944:294) to be conspecific with *Vultur gryphus*, which it equals in size. *Vultur patruus* (Lönnberg, *1902*) is based on a tarsometatarsus and femur from the Pliocene of Bolivia. It, too, Fisher thinks may be conspecific with *Vultur gryphus*; it is certainly larger than *Pliogyps* (*V. patruus*, tarsometatarsus, 118 mm. in length; *Pliogyps*, 94 mm.) although smaller than average *gryphus* (tarsus, 130 mm.). In any event, *fossilis* and *patruus* belong in *Vultur* and therefore are not closely related to *Pliogyps*.

Pliogyps fisheri new species

Type.—*Right tarsometatarsus, lacking trochlea for digit IV; edges of articular surfaces slightly worn; otherwise in excellent condition. Fully mineralized, light brown in color, trochleae pale tan.* University of Michigan Museum of Paleontology no. *38319*, from upper Pliocene, Rexroad formation, Rexroad fauna, Locality 3, Rexroad Ranch, W ½, SW ¼ Sec. *22*, T*33*S, R*29*W, Meade County, Kansas. Collected on July *25*, *1958*, by Claude W. Hibbard and party.

Diagnosis.—Same as generic diagnosis. *In size, tarsometatarsus larger than Coragyps and Cathartes; smaller than Vultur, Breagyps, and Gymnogyps; approximately the same length as Sarco-*

Fig. 1. Tarsometatarsus of *Pliogyps fisheri*, type, University of Michigan Museum of Paleontology no. 38319: upper left, proximal end; lower left, distal end; left to right, anterior, medial, posterior, and lateral views. Seven-eighths natural size.

ramphus papa but considerably more robust; somewhat larger than *Palaeogyps*; considerably larger than *Phasmagyps*.

Pliogyps fisheri is named for Harvey I. Fisher, in recognition of his definitive studies of the functional anatomy of the New World vultures.

Discussion.—The detailed studies of vultures by Loye Miller, Fisher, and Howard provide a basis for judging the adaptations of *Pliogyps fisheri*. Although it seems not to be closely related to any cathartid heretofore known, it is nevertheless a "condor,"—a relatively heavy-bodied bird, poorly adapted for rapid walking or running, and powerful in flight. Evidence for an essentially graviportal hind limb is provided by the thick columnar shaft of the tarsometatarsus, the relatively shallow excavations on the anterior face of the shaft and on each side of the hypotarsus, the nearly symmetrical flaring of the shaft both proximally and distally, the large proximal articular surfaces, and the extremely large trochlea for digit III. The total effect of the tarsus of *Pliogyps fisheri* is that of a symmetrically constructed support designed to bear considerable weight. A numerical evaluation of the sturdy proportions of the bone can be seen in table 1, where measurements and ratios of this bone are given for various cathartiform birds. *Pliogyps* is distinctive in this assemblage in the following ways:

1. In transverse diameter of the head in relation to total length of the tarsometatarsus, *Pliogyps* is equalled or exceeded only by *Teratornis* and *Breagyps*. In sagittal diameter of the head in relation to length, *Teratornis* and *Cathartornis* are the only genera which are greater than *Pliogyps*.

2. The transverse diameter of the shaft in *Pliogyps* is greater in relation to tarsal length than in any other vulture.

3. In sagittal diameter of shaft divided by total length, *Pliogyps* is exceeded only by the two teratorns and *Breagyps*.

4. The various ratios involving the dimensions of the trochlea for digit III show that *Pliogyps* has relatively the largest trochlea of any vulture studied and that this trochlea is narrower transversely in relation to the sagittal diameter.

Precise interpretation of these ratios is difficult. The extreme development of trochlea III would be expected in a strongly cursorial bird, as an adaptation parallel to that seen in ostriches and modern horses. It is inconceivable to me, however, that the short, robust, columnar tarsus belonged to a bird adept at running. Instead, the conclusion that *Pliogyps fisheri* was very heavy-bodied, short-legged, and consequently awkward on the ground seems inescapable. The large articular surfaces probably served primarily to support great weight. Digit III was probably very stout although perhaps not particularly long. Koford (1953:30) noted that the deepest part of the footprint of California Condors was made by the distal third of digit III. This is proof of the importance of this digit and its trochlea in supporting body weight.

Table 1

Measurements and Ratios of the Tarsometatarsus of Vultures

Measurements

Species and no. specimens	Total length	Proximal width	Distal width	Distance proximal end to tibialis insertion
Palaeogyps prodromus (type)	.....	19.5	.....	17.3
Cathartes aura (3)	68.0	14.4	15.3	10.3
Coragyps atratus (2)	81.5	15.1	16.8	12.0
Sarcoramphus papa (2)	98.5	20.8	23.5	16.0
Breagyps clarki (10)	120.1	27.6	29.4	22.0
Gymnogyps amplus (10)	125.0	27.4	31.2	21.7
Pliogyps fisheri (1)	94.0	21.9	.....	14.5
**Teratornis merriami* (over 25)	138.0	32.5	33.0	25.3

Species and no. specimens	Least transverse diam. shaft	Sagittal diam., middle of shaft	Transverse diam., trochlea III	Sagittal diam., trochlea III	Greatest sagittal diam. of head
Palaeogyps prodromus (type)	.....	.....	.....	.....	.....
Cathartes aura (3)	7.4	4.8	5.7	8.6	11.2
Coragyps atratus (2)	6.7	5.4	6.7	9.8	11.6
Sarcoramphus papa (2)	10.8	6.8	8.8	11.7	14.8
Breagyps clarki (10)	12.6	10.1	11.9	17.3	21.4
Gymnogyps amplus (10)	14.2	9.5	12.0	16.4	20.3
Pliogyps fisheri (1)	11.4	7.7	9.6	15.2	17.0
**Teratornis merriami* (over 25)	14.3	12.3	12.7	20.5	27.4

Ratios

Species	Trans. diam. head/ total length	Sagittal diam. head/ total length	Trans. diam. shaft/ total length	Sagittal diam. shaft/ total length	Trans. diam. trochlea III/ total length	Sagittal diam. trochlea III/ total length	Trans. diam. trochlea III/ sagittal diam. trochlea III
Cathartes aura	.212	.165	.109	.071	.084	.126	.663
Coragyps atratus	.185	.142	.082	.066	.082	.120	.684
Sarcoramphus papa	.211	.150	.110	.069	.089	.119	.752
Breagyps clarki	.230	.178	.105	.084	.099	.144	.688
Gymnogyps amplus	.219	.162	.114	.076	.096	.131	.732
Pliogyps fisheri	.234	.181	.122	.082	.102	.162	.632
**Teratornis merriami*	.236	.195	.102	.088	.091	.143	.635
**Cathartornis gracilis* (type)	.224	.188	.085	.087	.090	.146	.613

* Measurements and ratios from Fisher (1945:738).

There is little likelihood that a vulture so poorly adapted for running was flightless, even though the hind limb, because of its shortness, also seems poorly adapted for launching the bird into the air. Probably takeoff from level ground was accomplished primarily by flapping of the wings, which must have been extremely powerful to lift the heavy body, perhaps accompanied by a few hops but not by a long run. Fisher (1945: 739) suggested a similar method of takeoff for *Teratornis*; the launching problem faced by *Pliogyps* probably was as difficult as in *Teratornis*.

In mountainous terrain, Recent condors regularly jump from elevated perches on cliffs and trees for takeoff. Often, however, they find their food in valleys or on level plains and must therefore be able to fly from level ground. Strong winds make it easier for these heavy birds to take off from the ground. Consequently, terrain and wind velocity are important factors in their distribution (Koford, 1953:53). Undoubtedly the extinct condors were affected by the same factors.

These conclusions indicate that *Pliogyps* might well have nested in mountainous terrain and foraged over the Great Plains, where flight would be aided by the steady winds. *Pliogyps* probably fed on the horses, camels, proboscideans, and other large plains-dwelling herbivores of the Rexroad fauna.

Pliogyps fisheri shows no close relationship to other vultures. Its extreme specializations make it unlikely that it was ancestral to any known Pleistocene or Recent vulture.

Specimens examined.—*Pliogyps fisheri*, 1; *Gymnogyps amplus*, 10; *G. californianus*, 2; *Breagyps clarki*, 10; *Sarcoramphus papa*, 2; *Coragyps atratus*, 2; *Cathartes aura*, 3; *Teratornis merriami*, 10; various Accipitridae.

Acknowledgments.—Dr. Hildegarde Howard, of the Los Angeles County Museum, generously loaned me tarsometatarsi of fossil vultures from the Pleistocene tar pits of California for comparative purposes. Dr. Herbert Friedmann, of the United States National Museum, loaned me specimens of the California Condor. William L. Brudon, of the University of Michigan Museum of Zoology, made the drawings reproduced here. Partial support for this study came from a Faculty Research Grant from the University of Michigan Horace H. Rackham School of Graduate Studies. Paul Slud, Peter Stettenheim, Robert W. Storer, and Alexander Wetmore gave me helpful advice. I am grateful to Claude W. Hibbard for permission to study this interesting fossil.

SUMMARY

Pliogyps fisheri is described as a new genus and species of vulture of the Cathartidae from the Upper Pliocene of Kansas. Comparison of *Pliogyps* to fossil and Recent vultures indicates that it was a short-legged, heavy-bodied bird suggestive in proportions of the huge extinct teratorns. *Pliogyps* was probably clumsy on the ground but powerful in flight. Takeoff from level ground presumably was accomplished by vigorous flapping of the wings, perhaps accompanied by a few hops but not by a long run.

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RESPONSE TO EXPERIMENTAL LIGHT INCREMENTS BY ANDEAN SPARROWS FROM AN EQUATORIAL AREA

By ALDEN H. MILLER

In the study of breeding cycles of the Andean Sparrow (*Zonotrichia capensis*) in the wild near the equator (3° 30′N) in Colombia, South America, it was discovered that each male undergoes a six-month periodicity (Miller, 1959*a*). The high plateau of breeding potency normally lasts four months and the intervening regression, rest, and recrudescence of the testis occupies two months; two such cycles are passed through each year. Partly correlated with seasonal rainfall, a large proportion of the males in the population are in breeding condition during and just after the latter parts of each of the two annual wetter periods. Yet the control of events by rain, or wetness, however mediated, is incomplete inasmuch as nesting occurs in every month of the year in these sparrows at this location and the cycles of individuals may thus not be coordinate. The two periods of maximum participation in breeding fall close to the summer solstice and the winter solstice, respectively, for latitude 3° 30′N. Therefore, control or coercion by the weak seasonal photoperiodism of this area appears to be ruled out.

The question was posed whether this equatorial representative of the Andean Sparrow has a latent physiologic mechanism for response to light variations of greater magnitude than that which it normally experiences. In other words, does it have the same equipment for response as that possessed by its relatives of the same genus in North America? In planning to test this matter through experimental lighting an immediate difficulty arose of obtaining individuals with known prior history with respect to their reproductive cycles. One could not collect birds at a given time, as is done in the north, and assume that all would be essentially at the same point in the reproductive cycle. The number of individuals for which histories had been traced was small and these free-living birds were needed for completion of the study of natural cycles in the wild. Accordingly, experimentation was directed toward ascertaining the impact of added light on immature individuals whose age could be determined from the persistence of streaked juvenal plumage and/or the stages of the postjuvenal molt.

The problem and the findings need to be viewed against the background of experimental results on the Golden-crowned Sparrow (*Zonotrichia atricapilla* = *Zonotrichia coronata* or earlier nomenclature, see Stresemann, 1949) and the migratory races of the White-crowned Sparrow (*Zonotrichia leucophrys*). In these forms the treatment with an artificial day of 15 to 16 hours' length will stimulate the pituitary-gonad mechanism and lead to the development of the testes to full breeding size in 2½ to 3 months (Miller, 1954). If, however, this treatment is started too soon after the preceding breeding period or too soon after hatching in the case of immature individuals, the autumnal refractory period is encountered and no immediate or delayed response ever ensues. This refractory period terminates about the end of October or the first week of November (Miller, 1954; Farner and Mewaldt, 1955). In other words, under the normally conditioning light regime of the postbreeding period (see Wolfson, 1952), in which day length diminishes, the refractory situation disappears when young birds are 4 to 4½ months old. In this period the day length experienced ranges from 18+ hours down to about 11½ hours, with an average of roughly 14½ hours.

Young of *Zonotrichia capensis* were captured and placed in an outdoor experimental cage at our research station on the Western Andes, west of Cali, where there was a surrounding free-living population of marked birds which served as controls. The cage was 1 × 1 meters square and 2 meters high; it was provided with a 150-watt globe controlled by a time switch so that 4 hours of artificial light was added to a normal daylight period,

the aggregate being slightly over 16 hours. To avoid disruptive crowding only six young males were maintained at one time. They were given experimental light starting at ages ranging from 1½ to 4 months. Thus all were by comparison with *Zonotrichia leucophrys* and *Zonotrichia atricapilla* started at a time when they should be refractory.

RESULTS

A total of seven individuals that survived beyond ages of 4 months showed the results detailed in the following table.

Individual	Age at initiation of light dose	Age of attainment of breeding level	Length of light treatment before attainment of breeding level
872	2⅔ months	3⅔ months	1 month
897	2⅚	4⅓	1½
898	2½	6	3½
551	3¼	4½	1¼
552	4	6	2
005	1½	3	1½
881	3 7/12	5⅓	1¾

The age of attainment of breeding level was determined by laparotomies (Miller, 1958). When the testis was less than 7 mm. long but in the range from 3½ to 5 mm. the further recrudescence to be inferred from these sizes was extrapolated from experience with wild birds, wherein it was learned that three weeks is required for enlargement from 3.4 to 7 mm. Most laparotomies showed either full testis size or measurements 4.4 mm. or greater so that estimates to an accuracy of one weeks' time seem indicated. No. 898 is an exceptional case in that laparotomy at 6⅓ months revealed a 5.1 mm. testis, but the bird was then showing evidence of disease from which it succumbed 18 days later. When it died, the testes were again small (2 mm.). But at 5⅙ months a laparotomy had shown (2.9 mm.) that recrudescence was starting and it is probable that the bird attained full development at 6 months from which it was regressing a little later under the influence of disease.

The results, although variable in certain respects, are completely consistent in that all of the seven experimentals showed freedom from refractory reaction normal to northern zonotrichias. Despite the small number of individuals, this consistency makes it permissable to draw conclusions. The fact that some of the sparrows were started on extra light treatment as early as 1½ to 2⅔ months of age and nevertheless showed prompt positive response is furthermore a strong indication that we are not dealing here merely with a slightly shortened refractory period. No. 005, for example, attained a 4.6 mm. testis while still carrying some ventral streaking on the breast and while heavily involved in the postjuvenal molt. It seems clear that the refractory period is either entirely lacking or is radically shorter than in other species of *Zonotrichia*.

In the free-living population of *capensis* young males occasionally attain full reproductive state at 5 months, although normally this is achieved at 6 to 8 months. Certain of the experimentals did not reach breeding level before 5 or 6 months but it should be realized that in these cases the extra light was started long before the date of termination of refractoriness normal for *Zonotrichia leucophrys*; the light did not inhibit recrudescence in the way that it will when thus applied and maintained in *Zonotrichia leucophrys* and *Zonotrichia atricapilla*.

Another aspect of the results is consistent, except for the record of the sick bird no. 898. This feature relates to the promptness of response. Similar light dosages given during non-refractory periods in *leucophrys* and *atricapilla* must be applied for 2½ months at least to bring about full breeding level. In equatorial *capensis* this level is

attained in 1 to 2 months. Moreover, all four of the healthy birds that were started early enough on extra light to have made it possible for them to reach full reproductive level before the earliest known age for normal or control attainment of this state did in fact do so. These facts seem to indicate clearly that light has a positive stimulating effect.

DISCUSSION

The species of birds that nest at high latitudes and which generally utilize the stimuli of photoperiodism to perfect the timing of their seasonal activities receive values from the refractory period that follows the breeding season. This period serves to prevent a continued or recurrent gonad enlargement which might otherwise be induced by the days that are still longer than 12 hours in late summer and early fall. I have recently (1959*b*) offered the hypothesis that the postbreeding refractoriness is a positive adaptation for these high latitude species. Those birds that have evolved it conserve the energy that would be utilized in an unnecessary gonad enlargement and the attendant stimulated activities of song, courtship, and territorialism. Moreover, it prevents a reproductive effort that if started at this time would be abortive, wasteful, and dangerous to the adult because of the oncoming winter conditions. In other words, a photoperiod-controlled species must respond positively to light to attain breeding state at the proper time in the spring but it must also have a shut-off system to avoid extended or subsequent stimulation by this light which would be maladaptive.

Young individuals that have no need for recovery from a preceding active breeding state show the same autumnal refractoriness scheduled to extend over the same time (Miller, 1948) as the postbreeding refractoriness of the adults of the species. This circumstance especially points to the positive adaptive value of the refractory reactions, as there is no ready explanation why adults and young, the latter not in need of rest, would so perfectly coincide. Moreover, Wolfson (1955) has shown in Slate-colored Juncos and White-throated Sparrows that the extent of postbreeding refractoriness can be shortened by artificially providing long nights and short days. Thus it appears that refractoriness is a special blocking mechanism with threshholds gauged to the long days and short nights normal to late summer and early fall, a situation that can be upset by manipulation of the photoperiods at that time.

In thus viewing the postbreeding refractoriness as a positive adaptation, we should not confuse this mechanism with the independent tendency in males of all species to alternate regression and recrudescence, an innate tendency that results of itself in a somewhat loosely timed scheduling. This latter situation was especially brought to light in the tracing of individual histories in the wild equatorial population of *Zonotrichia capensis* (Miller, 1959*a*).

The apparent lack of a postjuvenal refractory period in *capensis* could be interpreted in at least two ways. It might be postulated that the period is present but is innately shortened compared to that of its northern relatives. Or it could be assumed that it is present in a form like that of its relatives but becomes diminished in expression by reason of the 12½ hour days and 11½ hour nights experienced from the time of fledging and before onset of artificial lighting. This latter view would not be discordant with results of Wolfson's experimental work (1952) on northern sparrows. Both of these hypotheses have the disadvantage of proposing the existence of a refractory mechanism in *capensis* that would never be important to the organism and would be inoperative in the light regime under which it lives. They would have the merit only of assuming a mechanism similar to that of related species.

Consequently the simplest postulate and therefore the most advisable in the absence of contrary evidence is that a postjuvenal refractoriness does not exist in equatorial

capensis. It has never developed or it has disappeared as a mechanism because it had no selective advantage. Such a view, conversely, points toward the likelihood that the refractory period has evolved in high latitude species to fit a particular and critical situation in their environment.

SUMMARY

In an equatorial population of the Andean Sparrow (*Zonotrichia capensis*) experiencing, the year around, day lengths of about 12½ hours, normal innate breeding cycles of wild males are of a six-month type, with four months of high reproductive potency and two months of rest and reconstruction of the pituitary-gonad mechanism.

Experimental light treatment of juvenal and immature birds in which they were afforded 16-hour days revealed no sign of a postjuvenal light refractoriness such as that found in high-latitude relatives.

Young males respond positively to light dosages on somewhat variable schedules but with sufficient constancy to conclude that this equatorial population has a latent light-response mechanism leading to stimulation of the gonads. Full reproductive level in males may thereby be reached at 3 to 4½ months of age whereas wild controls attain this rarely at 5 months and normally at 6 to 8 months.

Response to light is more rapid at the same dosages than in the Golden-crowned Sparrow and the migratory races of the White-crowned Sparrow.

It is hypothesized that a postjuvenal refractory period is entirely absent in equatorial representatives of the Andean Sparrow; it would have no meaningful function in such populations. Conversely it is proposed that the postjuvenal and postbreeding refractory mechanisms of high-latitude species are positive adaptations which avoid futile and wasteful late summer and autumnal breeding activity.

ACKNOWLEDGMENT

Essential and much appreciated support for research on *Zonotrichia* in South America was provided by the Guggenheim Memorial Foundation.

DEDICATION

I take pleasure in dedicating this paper to Erwin Stresemann on the occasion of his 70th birthday in recognition of his contributions to ornithology.

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CHANGE IN BODY WEIGHT ASSOCIATED WITH ONSET OF OVARIAN RECRUDESCENCE AND OVIPOSITION IN PHEASANTS

By CLARENCE L. NAGRA and IRVEN O. BUSS

A review of experimental investigations concerning the seasonal cycle in birds (Burger, 1949) indicates that it is controlled, at least in part, by a hypophyseal cycle which is environmentally regulated. In all truly wild temperate-zone species studied, the evidence suggests that change in daily photoperiod is the primary external factor to which the annual cycle is attuned, although other factors are assuredly superimposed on this basic control.

It is known in several species that an experimental elevation in ambient or environmental temperature will increase the rate of gonadal development (Farner and Mewaldt, 1953; Mitchell and Kosin, 1954; Engels and Jenner, 1956). Psychic factors may be important for the complete development of the female reproductive cycle in some species (Burger, 1949).

During an investigation of the dynamics of a wild population of Ring-necked Pheasants (*Phasianus colchicus*) in southeastern Washington, it was desirable to establish the approximate time for the onset of ovarian activity that results from natural photoperiodic stimulation of gonadotropic secretion. Information relative to gross development of the ovary and ovulation as well as associated changes in body weight are reported herein.

METHODS

Female pheasants were obtained in Whitman County, Washington, in the early morning as either field collected specimens or fresh, highway mortalities; only those road-killed birds estimated to have been killed within 24 hours of finding were used. Body and ovarian weights were taken upon return to the laboratory, and ovaries were either examined immediately for follicular development or placed in a 4 per cent solution of formaldehyde and examined at a later date. Ovarian recrudescence was determined by detecting changes in weight of the gonad and diameter of the largest non-ovulated follicle. Enumeration of post-ovulatory follicles during April and May was used to ascertain the number of ova ovulated (Meyer, Kabat, and Buss, 1947), and the date for onset of oviposition was estimated as suggested by Buss, Meyer, and Kabat (1951).

All birds that were collected in April and May possessed stimulated ovaries. In a few instances (6 per cent), females had not laid prior to collection. However, by comparing the size of non-ovulated follicles from ovaries of these hens with those of laying females, the time when laying would have begun was estimated by assuming a linear relationship to exist.

RESULTS AND DISCUSSION

Examination of the change in average weight of ovaries from January to April (fig. 1) reveals a curve that is exponential in form. A noticeable increase is evident in the last week of February, and this weight change is followed by continued ovarian growth subsequent to mid-March. Hiatt and Fisher (1947) report similar findings among pheasants in central Montana. Ovarian weight increased 77 fold from the first week of March to mid-April. The size of the largest non-ovulated follicle exhibited a similar trend. A correlation coefficient of 0.88 for the regression of follicle diameter on ovarian weight was calculated.

It is readily apparent that seasonal change in body weight parallels the pattern of growth manifested by the ovary (fig. 1). This phenomenon of increased body weight during spring among female galliform birds is well documented (Kirkpatrick, 1944;

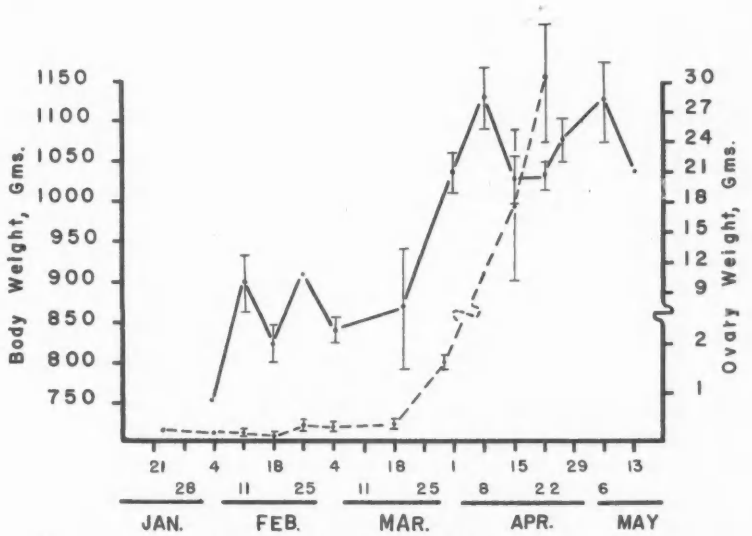

Fig. 1. Seasonal change in average body and ovarian weights of pheasants. Standard error is depicted as a vertical line when more than one specimen is on a given point.

McCabe in Stokes, 1954; Kabat, *et al.*, 1956; Bendell, 1955; Genelly, 1955). Breitenbach, Meyer, and Nagra (MS) have shown that depot fat stores are maximum in the hen pheasant at this time. Conceivably this fattening could result from the lipogenic action of estrogen, the secretion of which is increased in spring. Marked hyperphagia is known to occur during this period (Breitenbach, Meyer, and Nagra, MS).

In addition to the vernal change indicated by the ovary and body weight, a concomitant increase has been reported to occur in weight of the thyroid and adrenal as well as that of the liver, pancreas, gizzard, intestine, kidney, and spleen (Kirkpatrick, 1944; Breitenbach, Meyer, and Nagra, MS). Those organs concerned with digestion and assimilation of food may have hypertrophied as a result of the increased caloric intake. Hyperphagia and the indicated hypothyroid condition would also contribute to the accumulation of fat reserves.

Table 1

Dates for Onset of Laying as Determined by Enumeration of Post-ovulatory Follicles

Year	Sample size	Median date for first egg	Variation (days) Range	Quartile deviation
1950	31	April 11	26	5
1954	32	April 14	40	7
1955	23	April 17	21	4
1956	30	April 12	24	4
Pooled data	116	April 13	46	5

Onset of laying recurs with unvarying regularity between years (table 1). Because age, individual physiological condition, heredity, and other factors (Romanoff and Romanoff, 1949) may cause laying to be initiated in some birds either before or after an appreciable segment of the population is active, it was not surprising to find a consider-

able range between first-egg dates within a given year. However, the spread of the middle and most significant part of the data on first-egg laying is better than the extremes as an index to onset of laying within a population, since this segment of data will not be affected by the chance fluctuations of the extreme values (Freund, 1951). The middle 50 per cent of the females had laid their first egg within 4 to 7 days of the median dates. Seventy-five per cent of the laying hens that were collected had laid at least one egg by April 18. Initiation of laying was also first noted in mid-April among wild pheasants in central Montana (Hiatt and Fisher, 1947); the data of Buss, Meyer, and Kabat (1951) indicate April 23 to be the median date for laying the first egg among wild hens in southern Wisconsin.

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HABITAT DISTRIBUTION OF BIRDS BREEDING ALONG THE UPPER KAOLAK RIVER, NORTHERN ALASKA

By WILLIAM J. MAHER

Until recently all that was known of the distribution of birds in northern Alaska was based on work done at or near the arctic coast. Kessel and Cade (1958) have now broadened our knowledge by a report summarizing a large amount of data on the distribution of birds along the Colville River, the largest river system north of the Brooks Range. The following report is a record of the avifauna of an area along the Kaolak River in northern Alaska, west and north of the area covered by their report. The area lies on the northern edge of the northern foothills of the Brooks Range just south of their transition to the coastal plain. It is distant from any major river system and thus lacks many physiographic features and the accompanying diversity in habitats associated with large river valleys. In this respect it is considered representative of a large part of the outlying foothill area which is normally inaccessable to field parties.

The Kaolak River was visited in 1957 from July 8 through August 9, and in 1958 from June 21 to 27, and again from July 9 through August 15. The chief purpose of these visits was an investigation of the ecology of the populations of Parasitic and Long-tailed jaegers, but in the course of this work notes were gathered on all species of birds which were seen, and these observations form the basis of the present report.

ACKNOWLEDGMENTS

This paper is an outgrowth of a study of the population ecology of jaegers conducted at the Arctic Research Laboratory, Barrow, Alaska. Support for this work was provided by the Arctic Institute of North America under contract with the Office of Naval Research. The financial assistance of these agencies is gratefully acknowledged. It is a pleasure to acknowledge also the assistance of Max C. Brewer, director of the Arctic Research Laboratory. His considerable experience in the arctic and his generous counsel and support greatly facilitated the field operations. I also wish to thank Edward Clebsch for aid in identifying the plants of the Kaolak River area. At various times during both seasons I was accompanied in the field by Thomas Sovalik, James Harding, Jr., George Rosenfield, Gerald Brown, Sam Shushan, and Harry Sherman. Their assistance is greatly appreciated. Seth B. Benson and Frank A. Pitelka have read the manuscript critically and offered many suggestions.

DESCRIPTION OF THE AREA

The arctic slope of Alaska consists of three physiographic provinces, the Brooks Range, the Arctic Foothills, and the Arctic Coastal Plain. The foothill province is divided into northern and southern sections (Payne *et al.*, 1951). The study area, within the former section, is at latitude 69° 50′N and longitude 159° 56′W. The precise location given here is based on the Utukok River Quadrangle of the Alaska Reconnaisance Topographic Series, 1951 edition, published by the United States Geological Survey.

Topographically, the region consists of gently rolling ridges and hills, the tops of which are approximately equal in elevation (fig. 1). Drainage is well developed, there are few lakes and many of those present are relicts occupying large, partly drained basins. A few small lateral lakes are present near bends of the rivers. The rivers are mature with intrenched meanders; they have done little side-cutting.

The study area comprised approximately ten square miles of foothill tundra on the east side of the Kaolak River between its east fork and a large eastward bend of the main river. It is shown in detail on the accompanying map (fig. 2).

Fig. 1. General view of tundra along the Kaolak River. Riparian shrub habitat dominated by felt-leaved willows is seen at left-center (above beach) and also at right-center (in draws). Behind willows at left, *Carex* marsh is represented; beyond on slopes, tussuck-heath tundra.

The elevation of the river in the area is 60 to 70 feet above sea level. The river itself is small, about 60 feet wide, and shallow. Along its course there are narrow bluffs which may be occasionally as much as 40 to 60 feet high. From the river the terrain rises in a gently convex slope to a plateau approximately 150 feet above the river bed. Maximum elevation in the area is slightly less than 250 feet. On the plateau are two large relict lakes occupying a portion of a much larger basin now partly drained by a small stream.

Camp was located on a gravel bar 200 yards downstream from the confluence of the east and west forks of the river. From here the area was surveyed on foot. No field schedule was established the first season, but I was in the field almost daily and covered the entire area at least once a week. In the second season a regular schedule of weighing penned jaeger chicks was established. A route, which covered the south half of the area thoroughly, was traveled every three days. The north part of the plot was visited periodically to resurvey resident jaeger pairs. The areas west and south of the study plot were visited on occasion but most of the field work was concentrated in the area defined above.

CLIMATE

The climate of this region is severe; the winters are long and cold, but the summers are comparatively warm. The only climatological data available for this part of the arctic slope are from Umiat, situated 200 miles east in the Colville River valley, and they appear to be applicable here. Kessel and Cade (1958) have summarized the United States Weather Bureau data gathered at Umiat from January, 1947, through July, 1954. This brief discussion will be based on their analysis.

The mean annual temperature is 10°F. Winters are nine to ten months long; the coldest months are January and February, when the monthly mean drops below —20°F. The winter days are very short. At Umiat the sun remains below the horizon continuously from November 30 through January 10, and at the Kaolak study area it is not visible from November 26 through January 13. The summers are short and comparatively warm. The temperature rises above freezing in May and the snow pack begins to melt. The mean temperature is above freezing only for the months of June, July, and August. July is the warmest month, with a monthly mean of 43°F. The sun is above the horizon continuously from May 19 through July 24 at Umiat and from May 13 through July 27 at the Kaolak River.

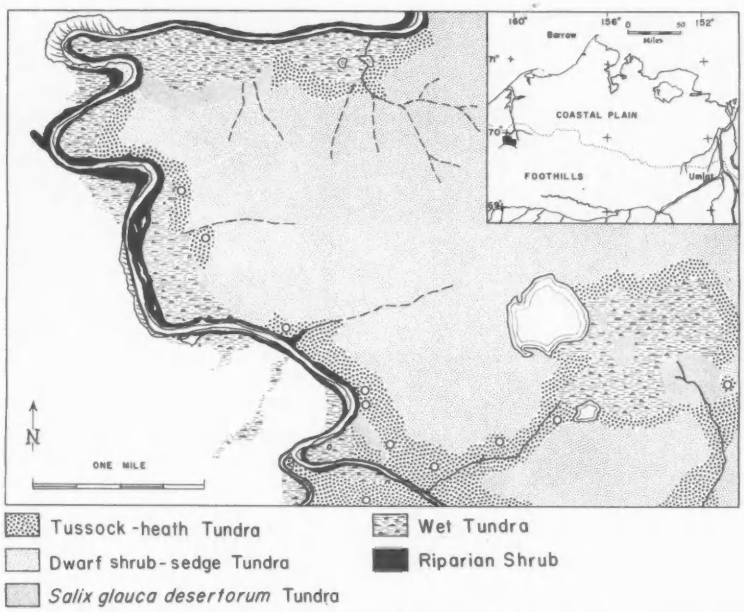

Fig. 2. Map of the study area showing the distribution of habitats. Upper right inset shows location of area. Small circles indicate location of territorial pairs of Golden Plovers in June, 1958. The unclassified area to the west of the river was not regularly surveyed.

Annual precipitation is low, averaging less than six inches a year. Almost half of this falls as rain in the summer months.

In the summer of 1958, I kept a record of daily maximum and minimum temperatures at the Kaolak River from July 15 through August 15. Daily mean temperatures averaged 55.5°F. in July and 53.5°F. for the first half of August; the means ranged from 47.0 to 64.0°F. The maximum temperature for that period was 81°F., the minimum 34°F. These data are summarized in table 1.

HABITATS

The vegetation of this area, as of tundra generally, has an outward appearance of monotony as a result of the generally low stature of the vegetation and the restricted number of life forms of the plants present. It has been demonstrated by Churchill (1955) and Bliss (1956) that quantitative analysis of tundra vegetation reveals a great diversity of community types. Communities distinguished on the basis of floristic composition, however, are of little significance to the student of bird distribution; yet it is apparent that the birds are responding to subtle differences in vegetation form. Hence, it is possible to differentiate meaningful ecological formations within the seemingly uniform tundra vegetation. I have recognized seven major habitats, four of which are based primarily on the life-form of dominant plants and three primarily on physical characteristics of the terrain. The distribution of these habitats on the study area is shown in figure 2.

Dwarf shrub-sedge tundra.--The upland plateau is covered by a formation charac-

terized by the presence of low shrub willow (*Salix pulchra*), 12 to 15 inches in height, and sedge tussocks (*Eriophorum vaginatum*). There is incipient polygonal patterning in this formation resulting in a characteristic microrelief consisting of level polygon tops separated by troughs 12 to 20 inches deep (fig. 3). The troughs tend to be narrow and deep near the edge of the upland, and broad and shallow toward the center where the terrain is more level. The troughs are filled with *Carex bigelowi, C. aquatilis,* and *Eriophorum angustifolium*. On the dryer polygon surfaces, in addition to shrubs of *Salix pulchra* and tussocks of *Eriophorum vaginatum,* various other sedges and grasses occur, including *Arctagrostis latifolia* and several species of *Poa*. Common and characteristic forbs are *Petasites frigidus, Pyrola grandiflora,* and *Pedicularis capitata*.

Table 1

Summary of Daily Fahrenheit Temperature Records, Kaolak River, Alaska, July 15 to August 15, 1958

Date	Mean	Extremes	Mean minimum	Mean maximum
July 15–31	55.5	39–81	44.2	66.2
August 1–15	53.5	34–81	42.1	64.6

As a result of the segregation of plants between the polygons, troughs, and the polygon tops, this formation looks like a level mosaic of broad willow patches 10 to 30 yards in diameter, surrounded by narrower grassy areas, three to 15 feet across. The relative proportions of the two structurally dominant species changes from place to place on the upland. In some areas *Eriophorum vaginatum* is dominant and the willow is reduced in prominence. In other areas the tussocks are reduced in size and number, or almost absent.

On the north end of the study plot where the upland slopes gently downward in a broad drainage pattern the tussocks are much reduced in number. Willow shrub is scattered, and *Betula nana,* which is not conspicuous on the rest of the upland, here becomes 15 inches tall. Grasses and especially sedges are luxuriant so that the polygonal and tussock character of the formation is obscured. It remains, however, basically a two-layered, low-shrub habitat. In the bottoms and sides of the few swales on the upland, as well as in protected places along the edge of the upland lake basin, the willows reach two feet in height.

Salix glauca desertorum becomes a conspicuous part of this formation on the breaks of the bluffs and in areas of the upland lake basin, as well as on the lower part of some slopes (fig. 3). In the latter two situations *S. g. desertorum* reaches three feet in height and forms an open shrub formation which is an important, although only a local, habitat-type. When necessary, this habitat will be referred to specifically.

The dwarf shrub-sedge tundra as here described is partly similar to Kessel and Cade's dwarf shrub habitat, although they describe it as limited to drainageways. Apparently they did not find broad areas of willow shrub.

Tussock-heath tundra.—Typical tussock-heath tundra is characterized by conspicuous tussocks of *Eriophorum vaginatum* and associated heath plants. It is the presence of the tussocks which gives it a characteristic basketball structure. "The tussocks vary considerably in size and number in different areas but commonly attain heights of 6 to 10 inches and somewhat lesser diameters. Channels between tussocks are usually only a few inches wide and occupied by mosses, lichens and vascular species" (Britton, 1957). Common heath plants associated with *E. vaginatum* are *Ledum decumbens, Vaccinium vitis-idaea, Cassiope tetragona,* and *Arctostaphylos alpina*. Another common associate is *Rubus chamaemorus*.

On the slopes of the upland plateau the vegetation differs from more characteristic tussock-heath tundras as described above. Here tussocks are not as well developed and

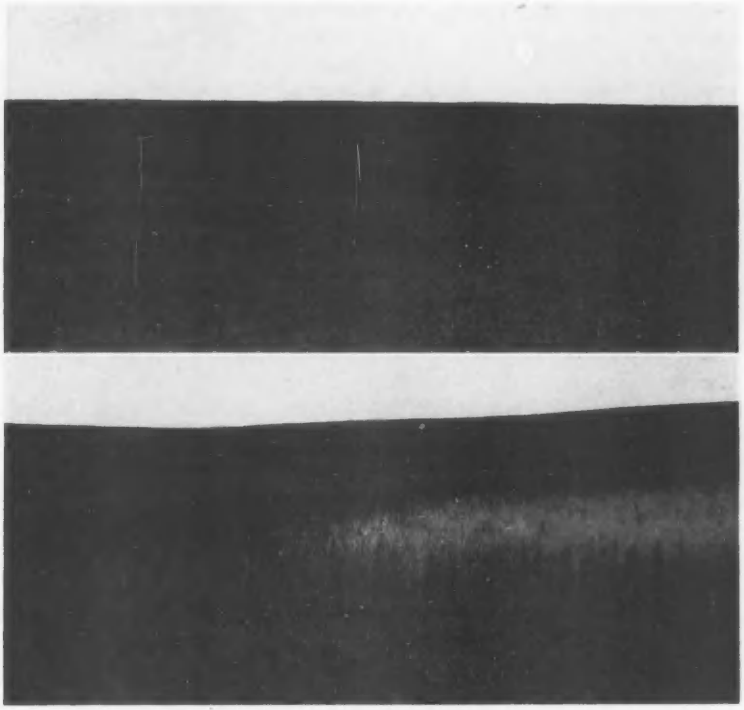

Fig. 3. Above, dwarf shrub-sedge tundra showing polygonal patterning, with dwarf willows occurring on polygon tops and sedges in broad shallow troughs.

Below, wet tundra, showing *Carex* marsh along edge of pond and adjacent wet tussock-heath tundra.

there is a greater abundance of grasses and sedges. Typical low shrubs such as *Ledum* and *Rubus chamaemorus* are absent. *Arctostaphylos* and *Cassiope* are rare.

This formation is equivalent in its more typical form to the tussock-heath tundra of Kessel and Cade (1958). It seems to include all four subtypes of Churchill's (1955) dwarf shrub heath type.

Wet tundra.—Wet tundra occupies the level land at the bends of the river and the lower part of the upland lake basin. As I have defined it here, it actually consists of two different plant formations, the *Carex aquatilis* marsh type, and a wet heath tundra. *Carex* marsh occurs in wetter areas, usually having water one to three inches deep overlying the substrate. The vegetation is almost entirely *Carex aquatilis*, other sedge species, and grasses. There is a broad area of this habitat around the two upland lakes and on parts of the river bends (fig. 3). *Carex aquatilis* marsh is equivalent to the formation of the same name of Churchill, and to the sedge-grass marsh of Kessel and Cade. A wet tussock-heath type is developed in some of the wet areas and sometimes interspersed with the *Carex* marsh in "low center" polygon areas. In some places it forms continuous stands. It is similar to typical tussock-heath tundra with greater abundance of sphag-

num moss and an increased importance of dwarf birch (*Betula nana*) and cloudberry (*Rubus chamaemorus*).

Riparian shrub.—Along the edges of the river, felt-leaved willows (*Salix alaxensis*) occur in dense stands. Here they reach a maximum height of 7 to 8 feet in a few favorable locations, although they average nearer 4 to 5 feet. This formation is never extensive, usually extending less than ten yards from the river. In a few places it extends into small draws in the river bluffs. *Salix alaxensis* is the most abundant species, followed by *S. richardsonii* and *S. arbusculoides* in order of decreasing frequency. Some characteristic forbs are associated with the riparian shrub. Most conspicuous of these are *Lupinus arcticus, Hedysarum alpinum,* and *Castilleja pallida*. This formation is the equivalent of the tall brush of Kessel and Cade. It is included in the *Salix* type of Churchill.

Fluviatile waters and alluvial bars.—This category includes the river and the gravel bars exposed along its course. The latter are not extensive along the Kaolak and are subject to occasional inundation. In 1957 they were covered entirely with water after the third week in July.

Lacustrine waters and edges.—Bodies of standing water are few in this area. There are several small lateral lakes and ponds near the river at the bends. They are apparently not numerous enough to attract a large population of the birds which nest in this habitat. On the upland are the two relict lakes already mentioned.

Cliffs and talus slopes.—On the outside of the river bends, bluffs may reach a height of 40 to 60 feet. Although these were utilized as perches by immature Golden Eagles, they are apparently not extensive enough to attract cliff-nesting species.

SEASONAL CHANGES IN AVIFAUNA

Of the species of birds known to nest at the Kaolak River, only the Willow Ptarmigan (*Lagopus lagopus*) is resident through the winter. The Snowy Owl (*Nyctea scandiaca*), the Gyrfalcon (*Falco rusticolus*), and the Common Raven (*Corvus corax*) are resident in the northern foothills in winter (Kessel and Cade, 1958), and transients may occur in the Kaolak River during this season.

Migratory species begin to arrive in early spring. I have recorded a Peregrine Falcon (*Falco peregrinus*) feeding on a freshly killed Willow Ptarmigan at Umiat on April 17, 1955. Redpolls (*Acanthis "hornemanni"*) and Snow Buntings (*Plectrophenax nivalis*) are also early arrivals. Redpolls were observed in the Brooks Range on the Killik River at Easter Creek in early March, 1954. A flock of 40 to 50 was seen feeding on exposed grass stems at Umiat on April 23, 1955, and large flocks fed along the cliffs of the Chandler River on May 1, 1955. Snow Buntings were observed as early as April 27, 1955, when three were seen at Umiat. A flock of 30 to 40 was also observed at Umiat on May 5 of that year. Most other summer residents, however, do not arrive until late May and early June.

Fall departure begins by mid-July when the shorebird eggs have hatched and the passerine young are leaving the nest. Adult Pectoral Sandpipers, Semipalmated Sandpipers, Dowitchers, and Northern Phalaropes, begin departing at this time. The Golden Plover and Bar-tailed Godwit begin leaving later in the month. By mid-August only an occasional group of juvenal shorebirds is still present.

Passerine juveniles complete their postjuvenal molt after the adults depart. They are still present in reduced numbers in mid-August.

MAMMALS PRESENT

One species of shrew (*Sorex arcticus*) and five species of microtine rodents were trapped on the study area. The latter consist of the collared lemming (*Dicrostonyx*

Fig. 4. A close view of tussock-heath tundra in which cotton-grass tussocks are dominant.

groenlandicus), the brown lemming (*Lemmus trimucronatus*), the red-backed vole (*Clethrionomys rutilus*), the tundra vole (*Microtus oeconomus*), and the singing vole (*Microtus miurus*). The arctic ground squirrel (*Spermophilus undulatus*) was common along the river banks. In 1958, a pair of red foxes (*Vulpes fulva*) raised a litter of at least three kits on the study area. These foxes were important predators on the ptarmigan and shorebird populations. The arctic fox (*Alopex lagopus*) and the wolverine (*Gulo luscus*) occurred as transients. Large numbers of caribou (*Rangifer arcticus*) migrated through the area twice each summer. Gray wolves (*Canis lupus*) were associated with the herds. Grizzly bears (*Ursus horribilis*) were seen occasionally; they were usually observed trailing behind the moving caribou herds. One fed on a caribou carcass near camp on July 28, 1958.

SPECIES LIST

Gavia arctica. Arctic Loon. A pair nested on one of the upland lakes in 1957. In 1958 two pairs nested, one on each of the two upland lakes. Both pairs were present on June 23. On August 14, a half-grown young was observed with the pair on the smaller lake. At the larger lake, on July 26, a nest was found three feet from the water's edge; it contained two eggs. On August 1 the eggs had not yet hatched. However, on August 14 the pair was seen accompanied by two small downy young. It is likely that these did not succeed in maturing before the onset of cold weather. These young probably resulted from a second nesting attempt, for on August 1 an empty nest, obviously constructed in the same season, was found on the shore of the same lake.

The larger lake is one-half mile across its greater diameter and the smaller one is one-eighth of a mile across.

Anas acuta. Pintail. None was seen in 1957. On July 24, 1958, a female was seen alighting on the river.

Anas carolinensis. Green-winged Teal. This species was not observed in 1957. In 1958 a pair was seen swimming on the river on July 23.

Aythya marila. Greater Scaup. Rare in this area. Two pairs were known to nest in 1957; none was recorded in 1958. An adult female was seen with five downy young on July 16, 1957, on a small lateral lake adjacent to the river. A second female, also with five downy young, was seen on the river on July 28 of the same year.

Clangula hyemalis. Oldsquaw. Rare in both seasons. This species was seen on the upland lakes, on lateral lakes, and on the river. On July 11, 1957, a downy young was found on the shore of one of the upland lakes. In 1958, on June 26, a pair was seen on the river below camp. A female and two downy young were seen on July 11 on a lateral lake along the same stretch of river. Adults were observed flying on several occasions during both seasons.

Mergus serrator. Red-breasted Merganser. Scarce in this area. It was seen only in 1958. A pair was observed swimming on the river on June 24. Several females and a male were seen on the river occasionally in late June and early July. In mid-July a female was frequently seen resting on a gravel bar above camp. On July 24, a female and eight downy young swam downstream past the tent. The following day a female and ten downy young also traveled downstream past camp. I cannot be sure that these were two separate broods, since I might have miscounted the number of chicks on one occasion. From the number of females seen earlier in the season, however, I consider it likely that two pairs nested in the vicinity. The crops of three of five chicks collected on July 25 contained the remains of small fish. All five of these downy chicks were males. Their weights were 56.2, 47.4, 49.2, 47.5, and 50.5 grams, respectively.

Aquila chrysaëtos. Golden Eagle. An immature eagle was resident in both 1957 and 1958. Occasionally a second individual was seen, but only one was present regularly each season. It frequented the low bluffs along the river and foraged over the entire area. On August 6, 1957, one was seen to stoop unsuccessfully at an adult Willow Ptarmigan. On August 14, 1958, one was attracted by a flock of ptarmigan which flushed ahead of me. It glided over and circled the spot where they had landed for several minutes before departing. On two separate occasions in July, 1958, I saw an eagle feeding on a caribou carcass on the tundra. Eagles were frequently harassed by Parasitic and Long-tailed jaegers.

Falco rusticolus. Gyrfalcon. Transient individuals were noted occasionally in both seasons.

Lagopus lagopus. Willow Ptarmigan. This species nested commonly in the area in both seasons. It seemed to be more abundant in 1958 than in 1957. In late June and early July, single males were commonly flushed on upland dwarf shrub-sedge tundra and some from among riparian willows. Only one nest was located. It was situated in a hollow among tussocks of *Eriophorum vaginatum* on a tussock-heath tundra slope. The nest was a simple bowl lined with grasses; it contained the shells of seven hatched eggs. Young were first seen on July 13 in 1957 and July 10 in 1958. Family groups were encountered in all habitats where good cover was provided by the vegetation. They were frequently flushed on the upland dwarf shrub-sedge tundra, and occasionally in riparian shrub and in the *Salix glauca desertorum* shrub tundra along the base of the hillsides. Five broods ranged from one to five in number, with an average of three.

There was some evidence of nonbreeding in the 1958 population. On June 26, 1958, I observed a group of three females and a male feeding together. Flocks of adults numbering up to a dozen were noted in riparian shrub by the last week in July. Males predominated in these groups. This may indicate a surplus of males in the population.

Ptarmigan were being heavily preyed on by a family of red foxes in the breeding season of 1958. In addition, two fox kills from the previous winter were found on the tundra, and a large number of winter kills were noted around the fox den on June 22. On July 11 the remains of ptarmigan chicks, mostly wings, were abundant by the same den. Few ptarmigan remains were found here later in the season, and it may be that the impact of the fox predation on the ptarmigan is greatest on the winter flocks and on the chicks before they are able to fly well.

Data on specimens are: ♂ ♂, July 21, 1957, testis 9 mm., weight 695 gm. (little fat); July 22, 1957, testis 7 mm., weight 613 gm. (little fat), testis 7.5 mm., weight 630 gm. (little fat); July 23, 1957, testis 7 mm., weight 585 gm. (little fat), testis 7 mm., weight 545 gm. (little fat), testis 7 mm., weight 560 gm. (little fat), testis 6 mm., weight 558 gm. (little fat). ♀, July 22, 1957, ova to 2 mm., weight 556 gm. (little fat). Jv., sex ?, July 12, 1957, weight 54 gm. (no fat); ♂ jv., July 22, 1957, testis 2 mm., weight 73 gm. (no fat); jv., sex ?, Aug. 6, 1957, weight 183 gm. (no fat). ♂ jv., Aug. 3, 1958, weight 222 gm. (no fat).

Grus canadensis. Sandhill Crane. A rare transient in this area. Two were seen in 1958 on August 1, calling as they glided in circles high overhead. They flew out of sight toward the west.

Charadrius semipalmatus. Semipalmated Plover. Uncommon. I have only one indication of breeding in the area: On July 16, 1957, I saw two adults and two newly hatched downy young on an alluvial bar. One other adult was seen on July 23 of that year in the same habitat. None was observed in 1958.

Pluvialis dominicus. American Golden Plover. A common nesting species, it was also the most conspicuous nesting shorebird in the area. In 1958, territorial pairs present at the end of June were mapped (fig. 2). Nesting density would seem to be two to three pairs per mile along suitable habitat. This mapping was incidental to other work, and the numbers indicated should be considered a minimal figure. As can be seen from the figure the habitat preference of these birds seemed to restrict them to the river course and to drainageways traversing the uplands. None was seen in the dwarf shrub-sedge tundra on the upland. The areas selected were tussock-heath tundra, the prerequisite seeming to be a lack of willow shrub and an openness of the vegetation. The birds also showed a preference for being on a slope; this is probably related to the need of territorial males for a prominent position for observing the surroundings. All nesting pairs were located either on slopes above the river, on the breaks of the river bluffs, or on the edges of lesser drainageways.

A downy chick weighing 91.4 grams was collected on July 16, 1958. This was the only chick seen. The plover population remained relatively constant in numbers through late July when all other shorebirds were already reduced in numbers or absent. On August 4, a flock of five flying juveniles was seen. Two flocks of 7 and 12, also of juveniles, were seen the following day. None was observed after this date.

Data on two specimens collected are: ♂, July 16, 1958, testis 6 mm., weight 134.1 gm. (little fat); jv.?, July 16, 1958, weight 91.4 gm. (no fat).

Capella gallinago. Common Snipe. Rare. On June 22, 1958, one was seen circling high and "winnowing" over a section of *Carex* marsh. This is the only record of this species for the two seasons.

Erolia melanotos. Pectoral Sandpiper. An uncommon nesting shorebird in this area. Birds exhibiting alarm at my approach, and thus suggesting the presence of chicks, were seen on the uplands in dwarf shrub-sedge tundra, and in *Carex* marsh at river bends and in the upland lake basin. They were never common, perhaps two to four individuals would be seen in a mile or mile and a half of uplands.

On July 10, 1958, a male downy chick weighing 37.7 grams was collected in *Carex* marsh. On July 16, a downy chick was found at a fox den. A flock of 16 adults was seen in the upland lake basin on July 11, 1958. By July 20 their numbers had dropped off noticeably. Several adults and approximately four flying chicks were flushed from *Carex* tundra along the edge of the upland lake on July 26, 1958. The last flocks seen that year, of four and five, respectively, were seen on August 4.

Data on specimen collected: ♂, Aug. 1, 1958, weight 61.0 gm. (little fat).

Limnodromus scolopaceus. Long-billed Dowitcher. An uncommon breeder. Two or three pairs were seen in 1957, and perhaps five or six in 1958. They seemed restricted to the *Carex* marshes near the upland lakes and at river bends. One territorial pair was seen in an area of tussocks and shrub willows in the upland lake basin in close proximity to *Carex* marsh.

On July 20, 1958, they were noted as decreasing in numbers. Four to six flying chicks were flushed from *Carex* marsh in the lake basin on July 26. On August 7, 1957, two young of the year were seen on wet tussock-heath tundra along the river. One juvenile was seen on August 13, 1958.

Data on specimens collected are: ♀ jvs., Aug. 1, 1958, weight 84.6 gm. (no fat), 97.5 gm. (little fat).

Ereunetes pusillus. Semipalmated Sandpiper. An uncommon breeding bird. A few pairs were seen in both seasons. The majority were observed in marshy habitats, one pair in a *Carex* marsh at a river bend and several others, perhaps four to six pairs, in the *Carex* marsh of the upland lakes. A pair was seen in the dwarf shrub-sedge tundra of the upland and another pair in *Salix glauca desertorum* shrub tundra in the lake basin. Although several males were seen displaying in the latter part of June, no nest or chick was ever found. Adults were observed frequently on alluvial bars in late July of 1957. None was seen after July 15 in 1958.

Data on specimen collected: ♂, July 13, 1958, testis 3 mm., weight 20.7 gm.

Limosa lapponica. Bar-tailed Godwit. Although scarce in this area, this species, because of its

noisy behavior, is one of the most conspicuous of nesting shorebirds. Its numbers seemed to be approximately the same in both seasons. In 1957 there were at least six pairs and possibly more on the study area. In 1958 there were seven and possibly eight pairs nesting.

All pairs noted in late June in 1958 were in the vicinity of Long-tailed Jaeger nests. Of 11 jaeger nests, five had one pair of godwits associated with it and one nest had two pairs. No godwit nests were found. The males made their presence known by springing up and screaming when I was approximately 150 yards from a jaeger nest. Usually they would remain with me circling, and screaming a continuous, high pitched metallic call: *yet'-a, yet'-a, yet'-a, yet'-a,* uttered rapidly with the first syllable heavily accented. The call was given with no variation in pitch and was continued for as long as I was within 100 to 150 yards of the jaegers' nest. During this period only one bird was seen at each jaeger nest, presumably the males which, according to Brandt (*fide* Bent, 1927:290), do not incubate. None was noted in the vicinity of three nests of the Parasitic Jaeger. One pair which acted as if it had chicks was observed in a *Carex* marsh at a river bend on July 15. This was the only pair observed in 1958 not associated with a jaeger nest.

In the course of the work on the two jaeger species in 1958, a record was kept of the occurrence of godwits through the season. Of seven pairs noted in late June, three pairs were still present on July 20. Only two pairs remained on July 26, and one on July 29. Two adults were seen separately on August 5, and on August 12 a group of three flying juveniles was seen.

The association of godwits with jaegers was not observed in 1957. In that year, of five pairs noted, two occurred together in wet tussock-heath tundra, one on a tussock-heath tundra slope along the river, one in a shrubby swale, and one on a slope of *Salix glauca desertorum* shrub tundra above an area of wet tundra. All of these pairs had chicks, judging by their reactions to my presence, so that it is impossible to say whether or not they had nested in the situations in which they were first observed. Nevertheless, I believe, from the fact that the association between the jaegers and godwits in 1958 continued through the season, that had it occurred in 1957, it would have been readily apparent.

A dead chick of this species was found at the mouth of a red fox den on July 16, 1958. On July 26, 1957, a two-thirds grown chick and one adult were observed in riparian shrub.

The stomach of an adult male collected on July 20, 1957, contained 70 partly digested land snails (*Succinea strigita*). I had made a special effort to collect land snails and observed this species of snail only in the riparian shrub. This fact, plus the fact that godwits were observed along the alluvial bars, especially late in the 1957 season, suggests that riparian shrub may be an important foraging area for this species. They were not observed in these habitats in 1958 (see discussion).

Data on two specimens collected: ♂, July 20, 1957, testis 7 mm., weight 261 gm. (little fat); ♀, July 21, 1957, largest ovum 1.5 mm., weight 304 gm. (no fat).

Phalaropus fulicarius. Red Phalarope. Rare in this area. Its breeding status is questionable. None was seen in 1957. In the following season, six were seen on June 22 in the *Carex* marsh of the upland lake basin. Two of these showed considerable alarm at my intrusion, and I thought they might be breeding. One other was seen the next day about some small tundra ponds at a river bend. No more were seen for the remainder of the season. I do not think they bred in 1958, but the presence of birds in breeding condition in late June indicates that they could breed occasionally.

Lobipes lobatus. Northern Phalarope. Seen regularly in small numbers in marshy areas and about all the ponds and lakes in the area in late June. On July 12, 1957, a male was seen leading three downy chicks through riparian shrub to the river. On July 10, 1958, a male with one downy chick was observed on a small pond 30 yards from the river. An hour later the same male and chick were seen swimming on the river. Single males were occasionally seen on tundra ponds until mid-July. By July 23, 1958, few were still present. One flock of four adults was seen on July 24 of that year.

Stercorarius parasiticus. Parasitic Jaeger. Three pairs nested in the area each season. They were spaced one and one-half to two miles apart. All three were located in wet tundra, two on river terraces and one in the upland lake basin.

In 1957, the eggs were already hatched by July 8. In 1958 all three nests contained two eggs; one of these was found pipping on June 27. All chicks were hatched by July 9. Flying young were seen on August 9, 1957. Adults were still present in mid-August of both years.

Stercorarius longicaudus. Long-tailed Jaeger. Five pairs of these jaegers were located on the study area in 1957. In 1958, 11 nests were found, eight of which were on the area surveyed in 1957. When I arrived on July 8, in the first season, all of the jaeger pairs present already had chicks, and since the

chicks are precocial, no nests were found. Of the 11 nests located the following season, eight had clutches of two eggs, and three only one. All but two of the clutches were hatched by July 9. One egg had hatched the previous day, judging by the size of the chick, and the other chicks were estimated to be from five to seven days old. One clutch of two eggs was infertile. The parents incubated until July 22, when I found the eggs cool. This nest was found on June 26. Had the eggs been laid on that date they should have hatched on July 22 at the latest. These eggs were found destroyed on July 24. One single-egg clutch was still unhatched on July 13. The fate of this egg is not known.

The majority of the jaeger nest sites were in dwarf shrub-sedge tundra, although there were a few in wet tundra and one in tussock-heath tundra. Nests on the upland were usually located on the sloping sides of the swales. No nest was present on the flattest part of the upland, although one at the upper end of a swale near the large upland lake was in an area of barely perceptible slope. Three nests were in the upland lake basin. They were distributed about its periphery within a few yards of the steeply sloping sides of the basin. Three nests were on river terraces, two of these in an area having prominent mounds. One was in an area of well developed tussock-heath tundra.

A factor of significance common to these sites seems to be their location on a slope, or the presence nearby of an elevated surface, from which the resting bird has unobstructed view of the terrain in the immediate area of the nest.

Flying young were first seen in 1957 on August 6. Adults were still present in mid-August of both seasons.

Parasitic and Long-tailed jaegers are the only avian predators nesting in the area. They are known to feed on shorebird chicks, passerine young and adults, Willow Ptarmigan chicks, microtine rodents, the least weasel, and insects, as well as carrion of all kinds. In 1958, they also fed heavily on cloudberries (*Rubus chamaemorus*) and blueberries (*Vaccinium uliginosum*) when they were ripe. More detailed data on food habits of jaegers and their role as predators in the tundra biome of northern Alaska will be presented elsewhere.

Larus hyperboreus. Glaucous Gull. Transient individuals were seen occasionally throughout both seasons. They normally foraged along the river course and rarely flew over the tundra. During the first week in August, 1958, a group of 12 remained in the vicinity of a caribou carcass on which they fed.

Larus canus. Mew Gull. This species was observed only once, on June 25, 1958, when an adult landed on a river bar near camp.

Sterna paradisaea. Arctic Tern. Several pairs were present about the large upland lake in both seasons. They were seen regularly foraging along the river course. No nests were located in 1957, although two adults with a juvenile just able to fly were seen at the large lake on July 27 of that year. On June 23, 1958, two nests were found on sphagnum mounds 30 yards from the edge of the same lake. They were 20 feet apart and contained one and two eggs, respectively. On August 1 a flying juvenile was collected here and along with it a downy chick. Two adults were still present on August 14, 1958.

Data on specimens collected: ♂ jv., Aug. 1, 1958, testis 1 mm., weight 114.5 gm. (moderate fat); ♀ jv., Aug. 1, 1958, weight 67.3 gm. (no fat).

Asio flammeus. Short-eared Owl. This species was observed only once. Late in the evening of July 21, 1958, one flew past camp downriver.

Corvus corax. Raven. Transient individuals were seen infrequently in both seasons.

Luscinia svecica. Bluethroat. An uncommon breeder, this species was found only in areas where willow shrub at least two feet high offered cover.

In 1957, I observed only one territorial male in the breeding season, on July 9. In the following year at least four pairs nested. Two of these were located on the edge of the upland lake basin where a narrow fringe of willow shrub two feet high offered cover. All other pairs observed were in riparian shrub. Owing to the extremely secretive habits of this bird, however, my observations may not reflect their actual abundance.

On July 11, 1958, adults of the two pairs on the uplands were seen carrying food. On July 12, a juvenile was observed in willows near camp, and on July 15, an adult and two juveniles were seen, also in riparian shrub.

Data on one specimen collected: Jv., sex ?, July 15, 1958, weight 12.5 gm.

Motacilla flava. Yellow Wagtail. A rare breeder. In 1957 an adult and "several" juveniles were

seen on July 9 in riparian shrub. A juvenile was found dead on a river bar on July 16. In 1958, one locally settled pair was observed on June 22 on tussock tundra adjacent to riparian shrub. This pair was not seen later in the season.

Lanius excubitor. Northern Shrike. A juvenal female (weight, 73.5 gms.) was collected in tall riparian shrubs on August 13, 1958. This is the only record for this species.

Acanthis "hornemanni." Redpoll. Baldwin (1955) as well as Kessel and Cade (1958) have pointed out an uncertainty regarding the taxonomy of Redpolls on the arctic slope. Following their lead I have assumed that the Redpolls occurring in the area were all of one species. At the suggestion of Frank A. Pitelka, the specific name heretofore applied to the common type of Redpoll in arctic Alaska (Bailey, 1948:292) is placed in quotation marks to emphasize the current uncertainty, pending results of studies now underway by Paul H. Baldwin. It should be noted that on the basis of studies in Greenland, Salomonsen (1951) already regards the arctic and subarctic races of Redpolls as all representing merely one species, *Acanthis linaria.*

Next to the longspur and the Savannah Sparrow, the Redpoll is the most abundant species of bird in the area. It is ubiquitous. In late June Redpolls are seen and heard in flocks in all vegetation types. As nearly as I could determine, nesting was confined to riparian shrubs and to hillsides of *Salix glauca desertorum* shrub tundra. The willows did not have to be very large to accommodate the Redpoll. One nest was found at the base of an open willow shrub which was scarcely 20 inches tall.

Seven nests were found in 1958. Five of these were in riparian shrubs four to seven feet tall. The nests themselves were placed two to two and a half feet from the ground. Two of these nests were well hidden in willows which had been crushed into a dense tangle by the ice of the spring break-up. The remaining three were quite exposed. Two nests found were on the ground in the base of *Salix g. desertorum* shrubs on hillsides sparsely covered with willow. The only nest located in 1957 was on the ground in the side of a tussock at the base of a slope of *Salix g. desertorum* shrub tundra.

Table 2

Breeding Data on *Acanthis "hornemanni,"* Kaolak River, Alaska, 1958

	Nests					
Date	1	2	3	4	5	6
June 21		3 eggs				
22	5 eggs	3 eggs				
23	5 eggs	Abnd				
July 10			3 eggs			
15			4 eggs			
16				2 eggs		
17				3 eggs		
19				5 eggs		
20					4 eggs	
26					4 eggs	
28					3 eggs, 1 chick	4 chicks
29					2 eggs, 2 chicks	4 chicks
30					1 egg, 3 chicks	4 chicks
Aug. 1					1 egg, 3 chicks	
3						4 chicks
4						0 chicks
6					1 egg, 3 chicks	

All breeding data are summarized in table 2. The average clutch size for the six nests found was 4.1 eggs. Nest number 2 possibly does not represent a complete clutch; the eggs were cold when found, indicating that they were already abandoned.

Baldwin (1955), in his study of the breeding cycle of the Redpoll at Umiat, in 1953, concluded that the Redpolls did not have second broods. Kessel and Cade (1958), on the basis of several records of eggs and naked young from early to mid-July, suggest the occurrence of second broods. My own data tend to support their suggestion.

On July 15, 1958, juvenal Redpolls were common in large flocks of juvenal fringillids occurring in the riparian shrub. From this peak their numbers gradually declined. A flock of approximately 15 was seen over the uplands on July 30. The juveniles were still abundant in riparian willow on August 6. Very few were seen after the first week in August.

Data on specimens: ♀, July 10, 1958, largest follicle 6 mm., 2 ruptured follicles, egg in oviduct, weight 13.4 gm.; ♂, July 14, 1958, testis 6 mm., weight 13.1 gm. (moderate fat); ♂ jv., July 14, 1958, testis 1.5 mm., weight 12.0 gm.; ♀, July 31, 1958, weight 12.0 (moderate fat); ♂ jv., July 31, 1958, testis 1 mm., weight 12.5 gm. (heavy fat).

Passerculus sandwichensis. Savannah Sparrow. An abundant nesting bird, this species ranks second in numbers only to the longspur. It nests primarily in the dwarf shrub-sedge tundra of the uplands. I have also recorded two pairs in the back edge of the riparian shrub where the willows are dwarfed to 12 to 24 inches in height. These showed alarm at my presence and were apparently nesting in this habitat.

No nests were found. Young were first seen on July 12, in 1957, and on July 10, in 1958. From mid-July until the end of the month the Savannah Sparrow was abundant on the uplands. On August 6, although its numbers were considerably reduced, it was still, with the longspur, the most numerous bird in dwarf shrub-sedge tundra. Its numbers continued to decline rapidly in early August, and only a few were present by August 14.

Because of its retiring habits and the lack of any penetrating quality to its song and alarm note, I found it difficult to judge the abundance of the Savannah Sparrow relative to the longspur. They are most conspicuous in July when the young leave the nest. At this time I estimated that they were one-third to one-half as abundant as the longspur. An interesting corroboration of this estimate is given by the data on birds caught in two snap-trap lines which were run to census microtine rodent populations. The lines were 1000 feet long with three traps grouped in a six-foot radius about stakes placed every 20 feet. There were 153 traps per line. They were set for three-day periods and were checked every 12 hours in that time. One line was located in upland dwarf shrub-sedge tundra and one in tussock-heath tundra. The data on the birds taken are given in table 3. These data tend to

Table 3

Birds Caught in Snap Trap Lines, Kaolak River, Alaska, 1958

	Habitat types				
	Dwarf shrub-sedge tundra		Tussock-heath tundra		
Species	July 18–21	Aug. 7–10	July 22–25	Aug. 10–13	Totals
Calcarius, adults	2	2	0	0	10
juveniles	4	0	2	0	
Passerculus, adults	2	0	0	0	4
juveniles	1	0	1	0	

confirm my own estimate of the relative abundance of the two species, and they also show clearly the preference of the Savannah Sparrow for the dwarf shrub-sedge tundra over the tussock-heath tundra. The decline in the populations of passerine birds in late July and early August is also reflected in these catches.

Data on specimens: ♀, July 16, 1958, weight 17.1 gm.; ♂ ?, July 19, 1958, weight 17.9 gm.; ♀, July 21, 1958, largest ovum 1.0 mm., weight 15.5 gm.; ♂ jv., July 21, 1958, testis 2 mm., weight 18.6 gm.; ♂ jv., July 25, 1958, testis 1 mm., weight 18.9 gm.; ♂, Aug. 3, 1958, weight 20.4 gm. (little fat); ♂, Aug. 4, 1958, testis 1.5 mm., weight 19.7 gm. (little fat); ♂ ?, Aug. 9, 1958, weight 16.5 gm.; ♂, Aug. 9, 1958, testis 1 mm., weight 18.7 gm.

Spizella arborea. Tree Sparrow. This species was uncommon. In June, 1958, I recorded four singing males and observed two pairs. They were associated with willow shrub two feet or more in height and were observed in riparian shrub, *Salix glauca desertorum* shrub tundra, and in dwarf shrub-sedge tundra on the sides of a draw where the willow reached two feet in height. None was seen on the upland at this time. The males do very little singing later in the season. In 1957, I obtained only one song record. A male was seen singing from riparian shrub on July 16. No nests were found in either season.

In mid-July of both seasons a few Tree Sparrows were recorded from upland dwarf shrub-sedge tundra. None occurred in the area after the end of July.

Zonotrichia leucophrys. White-crowned Sparrow. An uncommon nesting bird. It was observed only in riparian shrub. I recorded six pairs along a two-mile section of the river traversed frequently. This suggests a density of three to four pairs per mile of riparian shrub. Its numbers were comparable in the two seasons.

An adult feeding about my tent was carrying food into the willows on July 12, 1958. On July 13, the young appeared about the tent feeding with the adults. These were the first young seen. They fed actively on bread scraps and foraged about the base of the tent, eating mosquitoes. A few juveniles were seen on July 15, 1958, in the large flocks of fringillids which occur in the riparian shrub from mid-July until early August. White-crowned Sparrows were the only birds which fed about the tent, and they continued to do so until I left the area on August 15. On August 12, the young feeding about the tent were already in their postjuvenal plumage.

Data on specimens: ♂ jv., July 14, 1958, testis 2 mm., weight 29.1 gm. (heavy fat); ♀, July 17, 1958, largest ovum 1 mm., weight 27.1 gm.; jv., sex ?, Aug. 1, 1958, weight 27.6 gm. (no fat).

Calcarius lapponicus. Lapland Longspur. This is the most abundant nesting bird in the area. It occurs on the uplands in dwarf shrub-sedge tundra and on the tussock-heath tundra. It was also noted in areas of one- to two-foot willow shrub on the slope of the upland lake basin and in riparian shrub. All of these habitats were used for nesting except the riparian shrub.

In 1958, only one nest was found; it contained one egg on June 23. This nest was situated on a moss tussock under a dwarf birch (*Betula nana*) in an area of wet tussock-heath tundra. A fledgling barely able to fly was seen on June 25. Flocks of juvenal fringillids, mostly of this species, were seen on July 15 in riparian shrub. At the same time their numbers on the uplands dwindled, only occasional groups of five to 12 juveniles being seen on the uplands. By July 24, adults were few but juveniles remained common. Two days later their numbers had declined noticeably. The decline continued through late July, and on August 4 only a few were seen. This decline is well reflected in trapping data summarized in table 3.

A few juveniles in postjuvenal plumage were noted among several individuals seen on August 4, 1958. Individuals in this plumage were predominant by August 12.

Data on specimens: ♀ jv., July 15, 1958, weight 23.9 gm.; ♂ jv., July 15, 1958, testis 1.5 mm., weight 27.6 gm.; ♂ jv., July 19, 1958, testis 2 mm., weight 21.6 gm.; ♂ jv., July 19, 1958, testis 1 mm., weight, 26.5 gm.; jv., sex ?, July 20, 1958, weight 22.3 gm.; jv., sex ?, July 20, 1958, weight 24.1 gm.; ♂, July 20, 1958, testis 2 mm., weight 25.4 gm.; ♀ ?, July 20, 1958, weight 24.4 gm.; ♀ (?) jv., July 21, 1958, weight 20.7 gm.; ♂ jv., July 23, 1958, testis 1.5 mm., weight 22.5 gm.; ♀, July 23, 1958, largest ovum 1 mm., weight 25.6 gm.; ♀ jv., July 25, 1958, weight 22.4 gm.

DISCUSSION

A total of 34 species of birds was observed at the Kaolak River in the two years. In 1957, 25 species occurred of which 20 were breeding and one more, the Tree Sparrow, probably bred, also. Three species were transient, and the Golden Eagle was present as a non-nesting resident. In 1958, 32 species occurred. Nineteen of these were known to breed, and two additional ones possibly bred, also. Ten transient species and the resident Golden Eagle were also noted.

Irving and Paneak (1954) reported 47 species, all but two of which were nesting, in the Howard Pass region of the Brooks Range 150 miles south of the Kaolak River. Kessel and Cade (1958) recorded a total of 87 species from the Colville River, and listed 54 known breeding species from foothill tundra. The comparative paucity of breeding species at the Kaolak River is probably related to the limited ecological diversity of the area. Reference to the map (fig. 2) shows that two of the seven habitats, dwarf shrub-sedge tundra and tussock-heath tundra occupy approximately 80 per cent of the total area. The remaining 20 per cent is occupied mostly by wet tundra. Riparian shrub is distributed in a narrow band, seldom exceeding 30 feet in width, along the river. The

remaining two habitats, the river and alluvial bars, and cliffs and taluses, are of very limited extent.

Data on the status of all birds in the area as well as nesting habitats used by the species known to breed are summarized in table 4. The effect of inadequate amounts of certain habitats on representation of species utilizing these habitats is most evident in columns 6 and 7 of table 4. No cliff-nesting birds bred in the area in the two seasons. Three of the five cliff nesters occurring in foothill tundra were observed as transients. The other two, Peregrine Falcon and the Rough-legged Hawk, were not seen at all. We may assume that cliff-nesting species wandering through the area would have nested if

Table 4

Nesting Distribution and Status of the Birds of the Kaolak River, Alaska, for 1957 and 1958

Species	Status	Habitats						
		1	2	3	4	5	6	7
Gavia arctica	N						X	
Anas acuta	A							
Anas carolinensis	A							
Aythya marila	n						X	
Clangula hyemalis	N						X	
Mergus serrator	n						X	
Aquila chrysaëtos	R							
Falco rusticolus	T							
Lagopus lagopus	N	X	X					
Grus canadensis	A							
Charadrius semipalmatus	n					X		
Pluvialis dominica	N		X					
Capella gallinago	A							
Erolia melanotos	N	X		X				
Limnodromus scolopaceus	N	x?		X				
Ereunetes pusillus	N	x?		X				
Limosa lapponica	N	X		x				
Phalaropus fulicarius	n?			X?				
Lobipes lobatus	N			X				
Stercorarius parasiticus	N		X	X				
Stercorarius longicaudus	N	X	x	X				
Larus hyperboreus	T							
Larus canus	A							
Sterna paradisaea	N						X	
Asio flammeus	A							
Corvus corax	T							
Luscinia svecica	N	X			X			
Motacilla flava	N/n?		X?					
Lanius excubitor	A							
Acanthis "hornemanni"	N	X			X			
Passerculus sandwichensis	N	X			x			
Spizella arborea	N	X			X			
Zonotrichia leucophrys	N				X			
Calcarius lapponicus	N	X	X					

HABITATS: 1, dwarf shrub-sedge tundra; 2, tussock-heath tundra; 3, wet tundra; 4, riparian shrub; 5, fluviatile waters and alluvial bars; 6, lacustrine waters and edges; 7, cliffs and talus slopes. SYMBOLS: N, a species which nested in the area both seasons; n, a species known to nest in only one of the two seasons; R, a resident non-nesting species; T, transients, species seen infrequently in both seasons; A, accidental or vagrant, a species seen only once in the two seasons; X, primary nesting habitat; x, secondary nesting habitat.

their nest-site requirements had been met. During both seasons an immature Golden Eagle utilized the bluffs as a perch.

The alluvial bars along the Kaolak River are small. The record of the Semipalmated Plover is the only nesting record I have for this habitat. Three other species, Spotted Sandpiper, Glaucous Gull, and Arctic Tern, could be expected to breed on alluvial bars.

Dwarf shrub-sedge tundra occupies about 70 per cent of the area, yet only three species, the Lapland Longspur, the Savannah Sparrow, and the Willow Ptarmigan, nest in it abundantly. It also seems to be the primary nesting habitat of the Long-tailed Jaeger and of the Bar-tailed Godwit. Three passerine birds, the Redpoll, the Bluethroat, and the Tree Sparrow, which also nest in this habitat, do so only along cut banks and in draws where willow shrubs reach heights of two feet or more.

Tussock-heath tundra, which is the next most extensive habitat, is utilized by five species, and only one, the Golden Plover, is confined to it.

The *Carex* marsh wet tundra occupies very restricted areas around lakes and at river bends. As far as nesting shorebirds are concerned, it is the primary habitat type. Seven of the nine species of shorebird in the area nest in it wholly or virtually so, if the Red Phalarope is included as a nesting species. The Bar-tailed Godwit and the Parasitic and Long-tailed jaegers also nest in this habitat.

The species diversity and abundance of passerine birds seems largely determined by the extent and physiognomic development of the riparian shrub. Kessel and Cade (1958) list ten species of passerines which breed primarily in the tall willow brush of the Colville River valley. Five of these species are not present at the Kaolak River, and one, the Northern Shrike, was seen only once as a vagrant. The tall brush habitat in the Colville drainage ranges from three to 25 feet in height, with an average of eight to ten feet. In the Kaolak River area, as already mentioned, the riparian shrub averages four to five feet, with a maximum of seven to eight feet. It seems clear that the limiting factor here is the reduction in height and areal extent of the willow shrub. Without more precise data from intermediate areas, the limits of the requirements of these six species cannot be defined.

The response of the Northern Shrike, *Lanius excubitor*, is especially interesting. Suitable prey species are certainly present at the Kaolak River. The absence of willow tall enough to provide the shrike with suitable look-out perches may be the significant factor in this instance. Climate is not limiting to the distribution of birds in the foothills except as it acts on the vegetation. The response of the passerine species to the progressive northward decline of their nesting habitat is worthy of more precise study.

The same reduction in number of forms is shown in the nesting birds which are associated with lakes and edges. Only one of the three species of loon which nest in the foothills did so in this area. No geese or swans were observed. Five species of ducks occurred. These include all of the five species known to breed in the foothills. However, two, the Pintail and the Green-winged Teal, were passage vagrants and did not breed in either year. Two species which did breed, the Greater Scaup and the Red-breasted Merganser, did so in only one of the two years. Of the five species, only the Oldsquaw bred in both seasons, and only one nesting is known for each year.

This paper appears to provide the first definite report of breeding of the Bar-tailed Godwit in the foothill province. Kessel and Cade (1958) cite several records from the coastal plain only. Bailey (1948) reports it as breeding, although rarely, on the coastal plain inland from Barrow and also along the Meade River. He also records that Charles D. Brower considered the main breeding ground of this species to be 80 to 100 miles inland from Barrow. This would place it in the northern edge of the foothills. In western Alaska, *Limosa lapponica* has been reported from marshy coastal areas. Grinnell (1900)

found it "tolerably common" in the Kowak (now Kobuk) Delta at Cape Blossom where it was "generally found around marshy places far out on the tundra." In view of these previous reports of its predilection for marshy coastal areas, its occurrence at the Kaolak River is particularly interesting.

The nesting of this species in association with the Long-tailed Jaeger has not been reported previously. Dixon (1938:73), however, records an association of the Whimbrel (*Numenius phaeopus*) with nesting Long-tailed Jaegers in McKinley National Park. He suggests a mutual benefit to the two species from this association when he says "we found these two species closely associated during the nesting season. The curlews are excellent watchmen . . . the jaegers . . . drive away any caribou, gull, or other intruder which they find invading the common nesting ground. There appears to be no friction between the jaegers and the curlews . . . ." Protection from fox predation seems to be the most likely benefit to the Bar-tailed Godwit from this association at the Kaolak River. I do not think that the jaeger in turn benefits from the alertness of the godwit. The jaeger itself is watchful; one member of the pair is always in the vicinity of the nest or chick. The Long-tail is also extremely aggressive and hostile toward the fox and other predators. I have several records of foxes being put to flight by the combined attacks of the two jaegers of a pair.

An interesting feature of this association, as observed at the Kaolak River, is that it did not occur in both seasons. Although both the Long-tailed Jaeger and the Bar-tailed Godwit nested both years, they were not observed nesting in close proximity in 1957. In 1958, all of the godwits found in the period of incubation in late June were in the vicinity of jaeger nests. The association lasted through the season. The only factor of possible significance to the godwit that differed in the two seasons was the presence in 1958 of a family of red foxes in the area. It may be that the nesting of the godwits with the jaegers was a response to the presence of the foxes in the early part of the season. Another possibility which cannot be ruled out is that the godwits and jaegers nested together initially in 1957 as in 1958 but that in the former year, the absence of the foxes allowed the association to break down after the chicks were hatched. This would also explain the frequent occurrence of the godwit along the alluvial bars and in riparian shrub in the latter part of 1957, a fact which was not noted in 1958.

SUMMARY

A sector along the Kaolak River in northern Alaska was visited in the summers of 1957 and 1958. This report is an analysis of the nesting distribution of all species of birds observed there.

Seven major habitats are defined and characterized. They are dwarf shrub-sedge tundra, tussock-heath tundra, wet tundra, riparian shrub, fluviatile waters and alluvial bars, lacustrine waters and edges, and cliffs and talus slopes.

A total of 34 species was recorded in the two seasons. Twenty-one species bred in 1957 and nineteen in 1958. The nesting distribution in the major habitats is given for each species for which adequate data were obtained. Such information as was obtained in the two seasons on breeding biology, density, and population trends are presented.

It is suggested that the restricted area of three of the major habitat types at the Kaolak River (lacustrine waters and edges, cliffs and talus slopes, and fluviatile waters and alluvial bars) are responsible for the absence of several species in this area. It is further suggested that the reduced height and extent of the riparian shrub is the factor responsible for the absence from the Kaolak River avifauna of six passerine species which have been reported nesting in the foothill tundra of the Colville River valley.

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FROM FIELD AND STUDY

Unusual "Bunching" Behavior of Starlings.—On September 2, 1958, while driving southeast of Frederick, Frederick County, Maryland, my wife and I observed a "bunching" reaction of a flock of Starlings (*Sturnus vulgaris*) which seems to be unusual in several respects. A loose flock of about 25 individuals was flying over a plowed field when a Marsh Hawk (*Circus cyaneus*) took flight from the ground or a very low bush. The Starlings immediately closed to a dense group and veered quickly to one side. The harrier made no advance toward the bunched flock, but continued to flap, gaining altitude. When the hawk was about 15 feet off the ground, the bunched Starlings dived upon it from the rear, causing the larger bird to pull quickly to one side and lose about half its altitude. The Marsh Hawk paid no further attention to the flock, which was still densely bunched and flying erratically away from the hawk when we left the scene.

It is unusual that the bunching reaction was given in response to a hawk which exhibited absolutely no signs of attacking the smaller birds. Moreover, the evident aggressiveness of the behavior may also be unusual. Bunching is usually an evasive movement by pursued Starlings (Tinbergen, The Study of Instinct, 1951:169–170). However, it has been reported to have other functions. Tinbergen (Bird Life, 1954:19) mentions that bunched Starlings will fly above a hawk, thus distracting it from hunting. Although the circumstances are not fully described, Tinbergen also notes that "attacks" by bunched birds will actually cause a hawk to flee if it is not hunting too intensively (Social Behavior in Animals, 1953:55). The Starlings I saw definitely appeared to move together in an aggressive attack aimed at actively repelling the Marsh Hawk.

From these various reports, it appears that the bunching behavior may be oriented for evasion (probably when the Starlings' escape motivation is very high), for distraction (when attack and escape motivation are about equal), or for actually causing the predator to flee (when motivation is nearly pure attack).

Behavior which is motivated by simultaneously activated tendencies to attack and escape is by definition "hostile" in current ethological terminology. Moynihan (Auk, 72, 1955:256), in his excellent review of hostile behavior, suggests that most predator-reactions like mobbing and distraction displays "were originally evolved to induce an intraspecific response." It would be interesting to compare the Starling's bunching with other forms of predator-reactions and with intraspecific hostile displays to see what, if any, relationships exist.

Helpful comments on this note were kindly made by Dr. Andrew J. Meyerriecks.—JACK P. HAILMAN, *Bethesda, Maryland, January 26, 1959.*

Cave Swallow Nesting in Building Near Cuatro Ciénegas, Coahuila, México.—In a recent study of Texas populations of the Cave Swallow (*Petrochelidon fulva*), Selander and Baker (Condor, 59, 1957:345–363) call attention to the peculiar distribution of the species in México, where it is known only in the southernmost (Chiapas and Yucatán) and northernmost (Tamaulipas and Coahuila) regions. Since only four localities seem to be given for it in the north of México, one in Tamaulipas and three in Coahuila (Saltillo, Sabinas and Monclova), it seems worthwhile to record observations made in the vicinity of Cuatro Ciénegas, Coahuila.

At the Molino del Rey, a flour mill about three miles from Cuatro Ciénegas, from June 27 to July 2, 1958, I saw a mixed flock of at least 10 Cave Swallows, perhaps 30 Cliff Swallows (*Petrochelidon pyrrhonota*), and a few Barn Swallows (*Hirundo rustica*) hawking daily about buildings and a spring-fed stream. Barn Swallows were nesting in the buildings, but I saw no nests of Cliff Swallows and assumed they were using cliffs in the adjacent mountains.

On June 28, swallows were seen flying in and out of the second story of the mill. Investigation disclosed the occupied nests of three species of birds in one of the well-lighted, unoccupied rooms. A Say Phoebe (*Sayornis saya*) was incubating at a nest built upon a narrow board nailed across two ceiling beams. At the opposite end of the room, perhaps 20 feet away, in a nest fastened on the rough-hewn side of a beam, a Barn Swallow was incubating. Some 10 feet distant on the same beam, a Cave Swallow flushed from its nest and four slightly incubated eggs and flew from the building, giving a low cry. On the floor below this beam lay intact a newly made nest of Cave Swallow, together with

fragments of other mud nests, apparently destroyed by children. Four nest scars showed plainly on the beam between the two occupied swallow nests.

In a poorly lighted corner of an adjoining room, I found a second nest of the Cave Swallow. This one was fastened into the angle formed by a rough exposed stud and the plastered wall and was about nine feet from the floor and so close to the ceiling that it was difficult to remove the young birds, of which there were four, almost ready to fly. The nestlings flattened themselves in a row across the wide, flaring lip of the nest, all facing outward. On the floor beneath the nest were the eight half-shells of the eggs from which they had hatched.

After I had replaced the young and was standing near the nest, a parent bird entered the room with food. The young made hissing sounds, but the adult did not approach closer than about five feet and soon flew out again and continued flying by the windows, occasionally darting into the room for a moment.

On July 1, I collected the two larger young. When handled, they emitted a low gritty-toned *screet-screet*. Placed on a flat surface, they used their wings as props, moving around on their wrists, much in the manner of bats. When confronted with a cone of rolled newspaper, they backed rapidly into it until squeezed together in the very tip, and there they crouched, heads down, facing the opening. In a partly covered cardboard box, they scooted to the darkest corners whenever the lid was changed about to expose them to the indirect light. These specimens are now in the collection of George M. Sutton, University of Oklahoma.

When I returned to Cuatro Ciénegas on August 22, all nesting activities in the mill had ceased and no birds were seen in the building. Barn Swallows were still present but I failed to find a single Cave Swallow or Cliff Swallow.

I now examined the nest from which the two nestlings had been collected. Built with its long axis parallel to the wall, the nest measured approximately 8 by 5 inches at the rim and it was 6 inches deep, outside measurements. The rim sloped gently to a cup measuring approximately 3½ by 2½ inches and 2 inches deep, but the bowl had been so packed with lining that the young virtually had rested on a shelf. A few fine rootlets were pressed into the mud at the bottom of the cup, where considerable chitinous material from decomposed droppings and particles of feather sheathings had collected. On top of this waste was a layer of grass. The remaining space was filled with feathers—principally chicken and dove, with a single feather each of Chachalaca (*Ortalis vetula*), Brewer Blackbird (*Euphagus cyanocephalus*) and Great Horned Owl (*Bubo virginianus*)—bits of thread and string, and one narrow strip of screening silk, pieces of which were scattered on the mill floor.

Cave Swallows were found at two other localities in México in 1958. On June 30, at a cotton plantation 20 miles northwest of Cuatro Ciénegas, on the road to Ocampo, several were flying with Barn Swallows about the doors of houses of farm laborers. On July 6, at Los Indios Courts, Santa Monica, Zacatecas, southeast of the city of Zacatecas, I saw two or three Cave Swallows, again with Barn Swallows, flying around huge, long-abandoned, cone-shaped granaries, some of which had been converted into tourist quarters, now no longer in operation.

The birds at Cuatro Ciénegas seem to be the first reported Cave Swallows nesting in association with Barn Swallows. Their nesting in a building within the foraging territory of the Cliff Swallow was of special interest. Selander and Baker (*op. cit.*) show that in the southern part of its range, where the Cliff Swallow does not breed, the Cave Swallow sometimes uses buildings, as well as caves and cliff crevices, but they report that in the United States (and apparently also in northern México), where both species breed, it has not been known to nest outside of caves. They found "no record of the two species associating" in Texas; and they suggest that "where the two species are sympatric, as in Texas and New Mexico, nesting of *P. fulva* is restricted to caves by competition with *P. pyrrhonota*." Thanks are due Drs. Selander and Sutton for critical suggestions regarding this note.—Lovie M. Whitaker, *Norman, Oklahoma, April 10, 1959.*

Further Records of the Hudsonian Godwit and Mississippi Kite in New Mexico.—A recent note by Montgomery (Condor, 61, 1959:58–59) relative to the occurrence of the Hudsonian Godwit (*Limosa haemastica*) and the Mississippi Kite (*Ictinia misisippiensis*) in New Mexico prompts me to add the following records. On May 22, 1951, I collected an adult male Hudsonian Godwit on an intermittent pond near the western side of the usually dry playa known as Laguna del Perro,

Torrance County, New Mexico. Laguna del Perro is approximately 130 air miles northwest of the locality at which Montgomery recorded an individual of this species between May 16 and 20, 1958. When collected the godwit was being harassed by approximately 20 adult Avocets (*Recurvirostra americana*) which had occupied the pond area as a nesting site. The godwit skin (U.N.M.C.V. no. 173) is now in the collection of the University of New Mexico. Perhaps these two known records of this bird in the state give a true indication of its accidental status there. On the other hand, one wonders if a systematic investigation of the widely scattered ponds and reservoirs on the plains of eastern New Mexico would not prove the Hudsonian Godwit to be more common in that area during spring migration than is shown by the available records.

On May 13, 1955, I observed an adult Mississippi Kite (*Ictinia misisippiensis*) in an oak grove on the eastern margin of a large playa approximately 6 miles east of Cloverdale and 4 miles north of the Mexican boundary in Hidalgo County, New Mexico. I approached within 75 yards of the bird as it sat on the top of a weathered stub in the crown of an oak. It was watched for nearly five minutes, during which time it was repeatedly attacked by a male Sparrow Hawk (*Falco sparverius*). Cloverdale is approximately 300 air miles west-southwest of the vicinity of Roswell, New Mexico, from which Montgomery has reported three sight records of this kite in June, 1958.—JOHN M. CAMPBELL, *Yale University, April 12, 1959.*

Ruby-crowned Kinglet Feeding on Nectar.—The Ruby-crowned Kinglet (*Regulus calendula*) is a common winter resident in northern interior California. At Paradise, Butte County, in the fall of 1958, the first kinglets were observed on October 5, and by October 9 they were quite common. By October 13, a Ruby-crown had discovered our two hummingbird feeders, hanging in the ceanothus shrubs. Two or more Anna Hummingbirds (*Calypte anna*) were regular visitors to the red nectar bottles, and the Ruby-crown soon became a regular customer also; it continued until January 30. I have never seen more than one kinglet at a time, and I do not know if more than one individual comes to feed. The hummingbirds either hover in front of the bottle, or perch on the wire loop and feed for several seconds before flying away. The kinglet comes to the perch, takes a sip, flits away, comes back for another sip, and is always in motion. After several sips it flies into the surrounding shrubbery and in a few minutes it is back again. This goes on throughout the daylight hours.

As I could find no published record of Ruby-crowned Kinglets feeding on nectar, I wrote to the Tucker Bird Sanctuary, Orange, California, for information. In reply, Mr. John W. Williams writes as follows: "With reference to the Ruby-crowned Kinglet, we have had a similar experience with them. We have [two] that attempt feeding on the nectar in our bottles, but of course with the Bee Guards to protect they do not get nectar. Occasionally we leave the Bee Guard off to give them a feed."

Does the Ruby-crowned Kinglet also feed on the nectar of flowers if it is available?—JOHN MCB. ROBERTSON, *Paradise, Butte County, California, January 30, 1959.*

A Late Seasonal Record of the Yellow-breasted Chat.—On December 5, 1958, a Yellow-breasted Chat was caught in a trap I had set on the roof of an aviary in my garden at 923 South Longwood Avenue, Los Angeles, California. The trap was intended to recapture a sunbird that had escaped from the aviary and was baited with honey water. This record of the chat is one of very late date for its presence in southern California. Willett (Pac. Coast Avif. No. 21, 1933:149) records it in the fall only as late as October.—J. DELACOUR, *Los Angeles County Museum, Los Angeles, California, March 9, 1959.*

Bark-eating of Red-headed Woodpeckers.—While studying the territorial behavior of Red-headed Woodpeckers (*Melanerpes erythrocephalus*) which wintered in Seneca, Maryland (Kilham, Wilson Bull., 70, 1958:107–113, 347–358), I noticed that some individuals ate bark with increasing frequency from December, 1956, until May, 1957. On December 15, for example, I watched a Red-headed Woodpecker fly to the trunk of a river birch (*Betula nigra*) and remain at one place for 15 minutes, pecking lightly on the bark and resting intermittently. On close examination, I saw a series of shallow indentations. These covered several square inches and did not extend to the underlying wood. On the following morning the woodpecker worked on an adjacent birch in a similar manner

and on December 29 it was again pecking gently and eating pieces of bark from the first birch. Three other Red-headed Woodpeckers observed in December were all feeding on bark of pin oaks (*Quercus palustris*).

In continuing observations I found one Red-headed Woodpecker (RH–1) of particular interest. This individual was marked by having a red head and black back while retaining the black bars which distinguish the white primaries of an immature bird. RH–1 fed on the bark of a pin oak within its territory from December through April. The feeding areas were low and I could observe the woodpecker at a distance of 30 feet while using 7×50 binoculars. RH–1 flew to the trunk of the pin oak on December 22. It would peck two or three times, then eat bark from a small area only just begun and located below where a limb emerged from the trunk, 12 feet from the ground. The woodpecker

Fig. 1. Area of exposed inner bark on a pin oak where a Red-headed Woodpecker fed from December (at right within saw cuts) until March (at left).

was consuming something for I could see that no bits of bark were drifting away with the wind. I returned with a saw on the next day to excise the area for examination. After making four cuts, however, I found the bark too adherent to remove. RH–1 was feeding at the same place three weeks later and the area was now enlarged by a downward extension of several inches. It became even larger at a later date (fig. 1). The woodpecker shifted its attention to a new place in March. This area was directly above the one with the saw cuts and was 20 feet from the ground with a southern exposure. Direct sunlight made the exposed, bright yellow, inner bark of the pin oak particularly obvious. The area of exposed bark had a peculiar U-shape. The arms of this U, pecked and nibbled over repeatedly, grew to be 6 to 7 inches long by April. Bark-eating was most frequent in this month, if one could judge by the rate of growth of feeding spots in this and in other territories of Red-headed Woodpeckers. On April 9, I observed a woodpecker feeding for five minutes on a serpentine area six inches long on a pin oak. My son climbed to the place with a saw, hammer and chisel. Removal revealed that the serpentine outline had been tattooed through the inner bark on the wood underneath. Bark-eating continued until the Red-headed Woodpeckers departed in May, for on May 4 I had an excellent view of one of them feeding on an odd-shaped area of inner bark of a pin oak.

In summary, I had observed nine Red-headed Woodpeckers feeding on bark over a period of six months. The living trees involved included nine pin oaks, two river birches, one hackberry (*Celtis occidentalis*), and one red ash (*Fraxinus pennsylvanica*). Most of the bark appeared to be eaten in April.

One would like to know why the Red-headed Woodpeckers ate bark from limited areas on repeated occasions. These birds have not returned in two years and there has been no opportunity to continue investigations. It is of interest from an ethological point of view, however, that bark-eating is a habit common to at least two other genera of woodpeckers, as the following reports indicate:

(1) Writing of Yellow-bellied Sapsuckers (*Sphyrapicus varius*), Beal (U.S.D.A. Biol. Surv. Bull. 37, 1911:1–64) stated that "cambium, or the inner bark of trees, was eaten every month, but most in winter and spring. The greatest consumption is in April, 48.95 per cent . . . ." (2) Pynnönen (Ann. Soc. Zool. Fenn., 9, 1943:1–60) has described the bark-eating of the Great Spotted Woodpecker (*Dendrocopos major*) in Finland. On December 6, 1934, for example, he observed an individual which visited a single spot on a birch tree eight times for this purpose, but he further states that the habit did not become regular until March. Both of these species drill holes to obtain sap. The sapsuckers can obtain sap in mid-winter in Maryland, as described elsewhere (Kilham, Auk, 73, 1956:451–452), and Great Spotted Woodpeckers may drill holes for sap, as described by Witherby *et al.* (Handbook British Birds, vol. 2, 1940:284) among others. My hypothesis is that Red-headed Woodpeckers, as well as sapsuckers and the Great Spotted Woodpecker, may obtain sap in an alternate way by consuming bark into which it has permeated, and, possibly, become concentrated by evaporation, following repeated wounding of a tree in a single spot.—LAWRENCE KILHAM, *Bethesda, Maryland, January 23, 1959.*

The Starling Arrives in San Diego, California.—Sixty-nine years after the original American stock of Starlings (*Sturnus vulgaris*) was released in New York City, the species has finally reached the southwesternmost county in the United States. On February 4, 1959, the writer observed two Starlings at the intersection of 11th and C streets in downtown San Diego, California. Both birds flew low overhead, permitting positive identification; one Starling, already in breeding plumage, had the characteristic yellow bill coloring and the unmarked, iridescent green breast. This is the first recorded occurrence of the species in San Diego County, although it was reported in California (Siskiyou County) as early as 1942 (Jewett, Condor, 44, 1942:79) and has recently been recorded in Imperial County and as a breeding bird in Los Angeles County (Rainey, Van Hoose, and Tramontano, Condor, 61, 1959:57).—KEN STOTT, JR., *Natural History Museum, Balboa Park, San Diego, California, February 4, 1959.*

More Observations of the Least Petrel and Pale-footed Shearwater Off Southern California.—The Least Petrel (*Halocyptena microsoma*) was considered by Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:45) to be a "late summer or early fall vagrant" in the waters west of San Diego and only four occurrences for the state of California have been published to date. Observations of this species during the late summer and early fall of 1958 might indicate that this species occurs regularly in small numbers at this time in the extreme southern waters of the state. On September 1, 1958, about 40 individuals of this species were observed by me together with larger numbers of Black Petrels (*Loomelania melanis*), Leach Petrels (*Oceanodroma leucorhoa*), and Ashy Petrels (*Oceanodroma homochroa*) about 5 miles east of Pyramid Cove, San Clemente Island. Prolonged observations of these Least Petrels revealed them to be easily separable in the field from the other three species of petrels and a discussion of their field characteristics might be in order so as to aid in future identification.

When the members of our party first sighted petrels, it was evident at once that among them were some noticeably small birds with swift, erratic flight that kept them close to the ocean surface. Even when seen unaccompanied by other petrels, their very small size was evident. The boat gave chase, but at full throttle (about 18 knots) we could not maneuver fast enough to get a clear shot at them, although several were attempted, and so none was collected. In addition to their small size (about two-thirds that of the Ashy Petrels and one-half that of the Black Petrels) and characteristic swift flight, as contrasted to the fluttery flight of the Ashy Petrels, no whitish areas were visible on the under sides of their wings; such is to be seen in the Ashy Petrels. The very best field mark of the Least Petrel, which was easily seen when these birds were close to the boat, was the rounded or wedge-shaped tail as compared to the forked tails of the other petrels. The tail was also shorter proportionally than that of the other species seen. These latter field characteristics were especially evident when the birds veered and turned.

On September 13, 1958, six more Least Petrels were seen at a point about 8 miles west of Point Loma, San Diego County, and they were successfully photographed in motion pictures.

To date, all published observations of the Pale-footed Shearwater (*Puffinus carneipes*) along the California coast have been of birds reported near Monterey. On September 1, 1958, our party observed a single individual of this species about 15 miles east of the southeastern tip of San Clemente Island (approximately latitude 32° 50'N, longitude 118° 10'W). The bird when first sighted, was resting on the water in the company of some 40 Pink-footed Shearwaters (*Puffinus creatopus*). The boat gave chase immediately and as the bird flushed and flew the dark wing-linings and flesh-colored feet were seen clearly. Its flight was noted to be slow and somewhat sluggish. The afore-mentioned characteristics distinguished it at once from the abundant Sooty Shearwater (*Puffinus griseus*). Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:43) considered this species to be a "rare, though possibly regular, visitant in spring, summer, and autumn." This observation constitutes the first record of the Pale-footed Shearwater from southern California waters.—ARNOLD SMALL, *Los Angeles, California, January 22, 1959.*

Brown Thrasher in San Diego, California.—On November 25, 1958, in Golden Hill Park in San Diego, California, I observed a Brown Thrasher (*Toxostoma rufum*) for more than a quarter of an hour. Its russet back and tail and its heavily streaked breast were clearly visible. It finally took refuge in some bushes to escape harassment by two Mockingbirds. My wife and I found it again on November 26, and I saw it on November 27. The noise made by the bird in scattering leaves while feeding on the ground gave away its whereabouts in the underbrush. Each time it was in the same general area. A Brown Thrasher, presumably the same bird, was seen in this area by Louis L. Grimm of San Diego on December 21. The most recent published record for the Brown Thrasher in California is that of a bird collected at Joshua Tree National Monument in 1945 (Russell, Condor, 49, 1947:131). —ARTHUR MORLEY, *San Diego, California, February 11, 1959.*

The Eastern Brant at Humboldt Bay, California.—On November 23, 1958, a specimen of the Eastern or Light-bellied Brant (*Branta bernicla*) was taken on South Humboldt Bay, in Humboldt County, California. This appears to be the third record of this form in California and the fifth on the West Coast. The first specimen taken in California was reported by Bryant (Condor, 16, 1914:183) from near Bird Island on Arcata Bay, Humboldt County, January 30, 1914. The second was killed on Tule Lake Wildlife Refuge, Siskiyou County, on October 20, 1941 (Harrison, Condor, 44, 1942:130). The other two records are from Washington in 1929 and 1933.

I acquired the recent specimen from Bill Lyman and party of Eureka, California. The bird had been shot from a flock of four brant, three of which were Black Brant. The Eastern Brant was an adult female in good condition and fine plumage. Bill Lyman was kind enough to donate the specimen to Humboldt State College where it will be preserved in the museum of the Division of Natural Resources.—STUART L. MURRELL, *Humboldt State College, Arcata, California, December 27, 1958.*

NOTES AND NEWS

Harry R. Painton

The late Harry R. Painton was one of the four founders of the Cooper Ornithological Club in 1893. The foresight and interest of this man and his young colleagues of that day began a development which has flourished and has had most beneficial effects on ornithological science as every present member of our organization well understands. After Dr. Painton retired from his medical practice he resumed an active part in the Cooper Society and took justifiable pride in its growth and functions. He served in late years as President of the Northern Division and he became aware of the great advantages of stable finances to assure for all time the continued support of ornithological research and publication by the Society. The business managers of that time, W. Lee Chambers and C. V. Duff, were pursuing a sound fiscal policy of fund use and investment, aided by their investment counselors. Dr. Painton resolved to contribute in a major way to this undertaking through his will. Following his death, his bequest to the Society became known. The legal work connected with the settlement of the estate over a period of nearly four years has been skillfully handled by Vernon Barrett, prominent Los Angeles attorney and member of the Cooper Society.

C. V. Duff and Ed. N. Harrison (left and center) of the Cooper Society receiving securities of the Painton Estate from Douglas F. Scott (right), Vice-president of Bank of America.

The trust department of the Bank of America has been most cooperative in this undertaking. C. V. Duff, Business Manager, is responsible for the coordinating work and for the very successful selection of securities available to the Cooper Society as its equity in the estate which has led to growth in benefits in the period of litigation. Accordingly Mr. Duff is now able to report that on August 20, 1959, he received securities and cash in the amount of $61,128.07 from the Harry R. Painton Estate as an addition to the Society's endowments. The members of our organization are deeply thankful to Dr. Painton and to these men concerned with business affairs for their dedication to the welfare of the Society.—A.H.M.

ANNUAL BUSINESS MEETING OF COOPER ORNITHOLOGICAL SOCIETY, 1959

The first session of the annual meeting of the members of the Cooper Ornithological Society (a corporation) was called to order by President J. R. Pemberton in 2503 Life Sciences Building, University of California, Berkeley, California, at 10:35 a.m., Friday, April 3, 1959.

The minutes of the meeting of 1958 were read and approved. The following committees were appointed: Committee to Examine Proxies, Thomas R. Howell, Robert T. Orr, A. Starker Leopold, chairman; Committee on Nominations, William H. Behle, Jean Delacour, Junea W. Kelly, chairman.

The thirteen proposals for membership were

read (names and addresses in Secretary's files).

There being no further business, the meeting was adjourned until April 4.

The second session of the annual meeting of the members of the corporation was called to order by President J. R. Pemberton in 2503 Life Sciences Building, University of California, Berkeley, California, at 9:15 a.m., Saturday, April 4, 1959.

A. Starker Leopold, Chairman of the Committee to Examine Proxies, reported proxies for 884 members, and 98 members present in person. A quorum was declared present.

William H. Behle, reporting for the Committee on Nominations, moved that the present slate of Directors of the Corporation be re-elected for the ensuing year. The motion was seconded and carried unanimously.

Thomas R. Howell presented a resolution extending the thanks and sincere appreciation of the Society to the Local Committee under the chairmanship of Howard L. Cogswell, to the Museum of Vertebrate Zoology, and to the University of California, for the excellent arrangements which had been made for the annual meeting. Howard Cogswell amended this resolution to include the name of Mrs. Joseph Grinnell. The amended resolution was unanimously adopted.

C. V. Duff, Business Manager, presented his report. In 1958, the market value of securities held by the corporation totaled $122,134.50, an increase of $33,069.87 over 1957. Membership in 1958 showed a gain of 126 members over 1957, giving the Society a total membership of 1639, the largest in the Society's history.

There being no further business, the meeting stood adjourned.—JOHN DAVIS, *Secretary*.

At the meeting of the Board of Governors on April 3, 1959, the details of business and editorial reports were considered and advisory functions exercised relative to the work of officers and the Board of Directors. The Board of Governors re-elected its officers on recommendation of the nominating committee. The officers are: John Davis, President; Thomas R. Howell, Vice-president; Kenneth Stager, Secretary.

At the recent annual meeting of the American Ornithologists' Union in Regina, Saskatchewan, George H. Lowery, Jr., was elected President. Dean Amadon and Austin L. Rand are Vice-presidents, and Herbert G. Deignan and Charles G. Sibley continue as Secretary and Treasurer, respectively. Donald S. Farner is the new editor of The Auk, succeeding Eugene Eisenmann. Alexander Wetmore received the Brewster Award for his work on fossil birds and on the classification and nomenclature of recent birds. New fellows elected were John Davis, Thomas R. Howell, and A. Starker Leopold. New elective members are H. Lewis Batts, Pershing B. Hoflund, C. Stuart Houston, Richard F. Johnston, Martin H. Moynihan, and Robert K. Selander.

Applications for Fuertes Research Grants of the Wilson Ornithological Society during 1960 are now being received. The committee recommending the grants wishes to emphasize that any type of ornithological research may be supported and that recipients need not be affiliated with educational institutions. In fact, the committee hopes to encourage the development of research by amateur ornithologists. The important criterion in making awards will be the potential contribution to knowledge intrinsic in the work envisioned.

The committee trusts that those interested in ornithology will encourage and stimulate qualified persons to apply. Information and application forms may be obtained from Harvey I. Fisher, Department of Zoology, Southern Illinois University, Carbondale, Illinois.

For Sale, Exchange, and Want Column—Each member of the Cooper Society is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line. Send advertising copy to Jack C. von Bloeker, Jr., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.

WANTED—"A Distributional Survey of the Birds of Sonora, Mexico," by A. J. van Rossem. Please state price and condition.—SEYMOUR H. LEVY, *Route 9, Box 960, Tucson, Arizona.*

CHRISTMAS BINOCULAR SPECIAL—7 × 35, center focus, $27.75 (plus 10% tax)—importer's price $41.50—and OURS, of course, has been PRE-SERVICED by us! All defectives returned to importer; each sold shock-tested, loose parts fastened, and alignment adjusted to 1/1,000. Like everything we sell, each has our famous FREE-SERVICE GUARANTEE. Our catalog includes Bausch & Lomb, and complete line of finest Japanese binoculars, with 6 models specially adapted by us for bird watching. Also, Bausch & Lomb and Bushnell 'scopes with threaded boss (made by us) for mounting 'scope directly on tripod, plus shoulder carrying strap, wide field 20x eye-piece giving 100% more viewing area, and accurate rotating turret. All instruments postpaid on 30-day trial; Christmas gifts on trial until January 10, 1960. (If ordered after December 1, 1959, request Special Handling shipment at our expense.) Send for catalogue and copy of "Know Your Binoculars" reprinting our article published in Audubon Magazine, 10¢—no charge to COS members.—THE REICHERTS, *Mirakel Optical Co., Mount Vernon 15, N.Y.*

FOR SALE—Back numbers of The Condor, The Nidologist, Wilson Bulletin, The Oologist, The Osprey, Ornithologist & Oologist, The Murrelet; each 25¢. The Auk, each 50¢. Calif. purchasers add 4% tax.—F. N. BASSETT, *722 N. Orange Dr., Los Angeles 38, Calif.*

FOR SALE—Complete run through vol. 9 (1950–1958) of Bulletin Kansas Ornith. Soc., $3.30, or 10¢ per number—cash, check, or stamps.—RICHARD F. JOHNSTON, *Museum of Natural History, Univ. Kansas, Lawrence, Kan.*

SPECIMEN CABINETS—Write for complete details and specifications on Specimen Case # 112, designed by the University of California, size 27″ × 44″ × 42″, priced at $199.00, F.O.B. Escondido, Calif.—CHAPPELL'S HOUSE OF WOODCRAFT, *P. O. Box 1085, Escondido, Calif.*

PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Society. Practically all the Society's money goes into the journal; neither the editor nor the business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles should contain original material and indicate its significance. They must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

In the interests of accuracy and economy, observe the following: do not duplicate data in text, tables, or charts; check citations to original sources and verify text references; quoted statements must be exact replicas of the original; use vernacular names applicable to the entire avian species (for a guide in this regard, consult the A.O.U. Check-list of North American Birds, Fifth Edition, 1957; insert scientific names for species but not the subspecific name except in taxonomic papers or where the race concerned has been critically determined by the author or his collaborators on the basis of specimens; revise the manuscript repeatedly to remove superfluous words and phrases, immaterial detail, and repetitious statements.

Note Condor style and usage. "General Articles" and the "Field and Study" items are set up in different form. Provide a concise, meaningful title, and, where needed, subtitles within the text. Footnotes are not used. The address line may serve to indicate institutional connection, and to it should be added the date of transmittal of the manuscript. Terminal bibliographies are usually desirable where five or more titles are to be cited; otherwise, the references may be included in the text. For bibliographic style, note closely the practices employed in recent volumes of the journal. A factual summary is recommended for longer papers.

Rules for copy.—(1) Typewrite material, using one side of paper only; (2) double space all material and leave liberal margins; (3) use $8\frac{1}{2} \times 11$ inch paper of standard weight (avoid onion skin); (4) carbon copies are not acceptable; (5) place tables on separate pages and plan them to fit normal page width; (6) number pages in upper right hand corner.

Illustrations.—Photographs should be glossy prints of good contrast. Make line drawings with India ink; plan linework and lettering for at least ½ reduction; do not use typewritten labels on the face of the drawing. Provide typed legends on separate sheets.

Helpful references on writing: Manual of Style, University of Chicago Press, and Rules of the Editorial Committee, University of California Press. On scientific nomenclature: Fifth Edition of the A.O.U. Check-list, The Distribution of the Birds of California (Pac. Coast Avif. No. 27), and The Distributional Check-list of the Birds of México, Parts I and II (Pac. Coast Avif. Nos. 29 and 33); authors are not required to follow the nomenclature of these works.